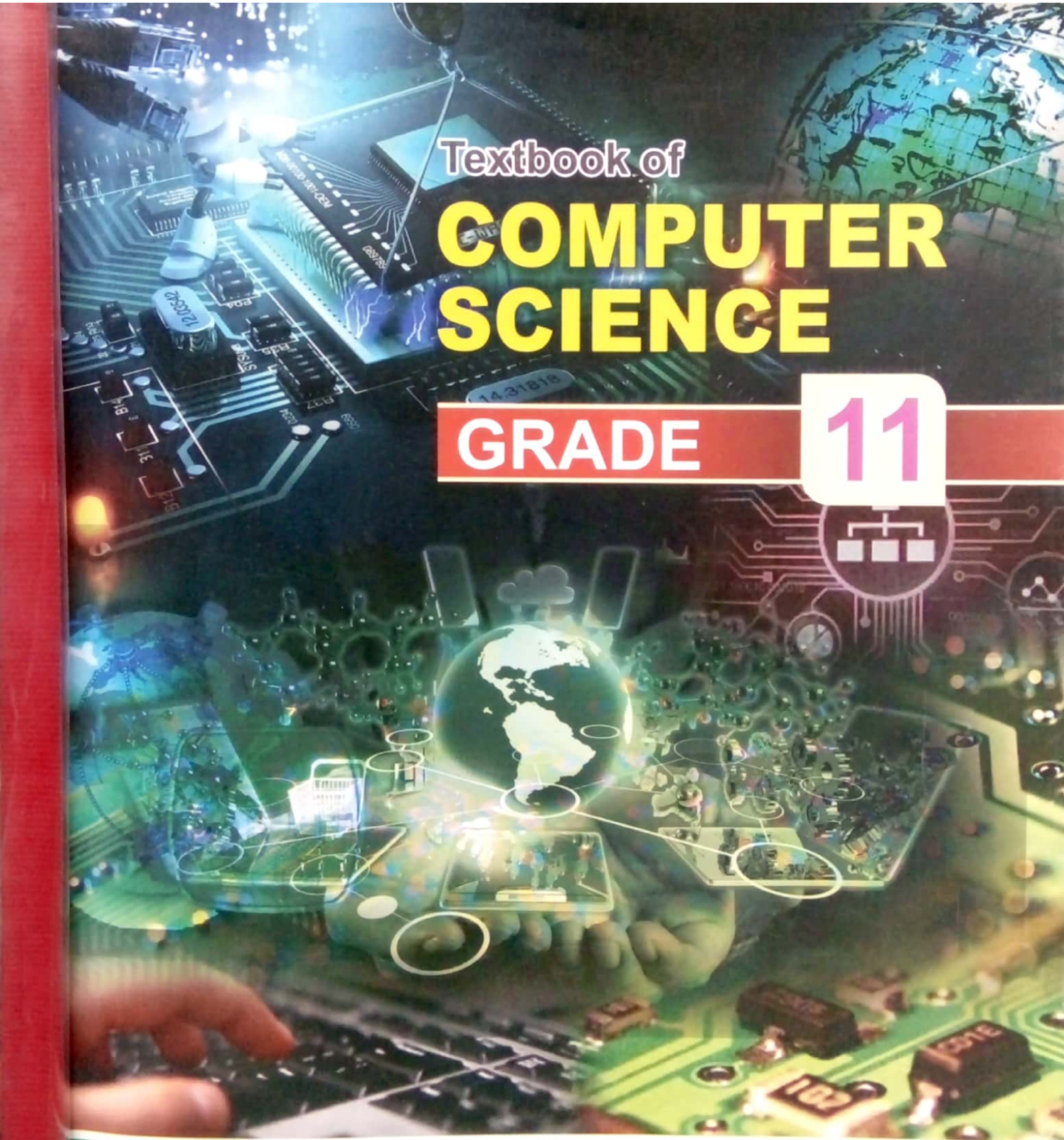


Textbook of
COMPUTER SCIENCE
GRADE 11

National Book Foundation
as
Federal Textbook Board
Islamabad

Textbook of

COMPUTER SCIENCE

Grade

11

National Book Foundation
as
Federal Textbook Board
Islamabad

PREFACE

COMPUTER SCIENCE for GRADE - 11 is developed according to the National Curriculum 2006 and National Style Guide. It is presented under the new management and supervision of textbook development, principles and guidelines with new design and layout.

Computers have impacts almost on every aspect of modern daily life and will continue to do so in the future as more advanced technologies are developing and implementing. In the present world, it is practically impossible to find any facet of life that is not influenced by computers in one way or another. Computer plays a vital roll and it is backbone of the infrastructure of modern civilization, controlling everything including bank accounts, the stock markets, medical records, the power grid stations, utilities, nuclear weapons, and much more. Computers have ushered a new era of automation that has increased productivity and efficiency. Tasks that used to take hours or days to complete can now be finished in the blink of an eye with the help of modern computers. To be successful, computer literacy is now a need of an hour.

Computer Science for Grade - 11 is designed according to the needs of present day students. Care has been taken to ensure that all new topics in the syllabus are adequately covered. Throughout the book, there is an emphasis on the practical work rather than theory.

Our efforts are to make textbooks teachable with quality, i.e. maintaining of standards. It is a continuous effort and we will get feedback of the yearly feasibility reports and redesign the textbook every year.

Like before, the National Book Foundation has made specific endeavours to publish the text and illustrations in much effective pedagogical form. The meticulous effort of the team is acknowledged.

Quality of Standards, Pedagogical Outcomes, Taxonomy Access and Actualization of Style is our motto.

With these elaborations, this series of new development is presented for use as per SOP's 2010 and NCC Standards 2016.

M. YUSUF M. BALUCH

Prof. Dr. Inam ul Haq Javeid
(Pride of Performance)
Managing Director
National Book Foundation

TABLE OF CONTENTS

CHAPTER 1 OVERVIEW OF COMPUTER SYSTEM 08

Introduction to Computers 08

1.1.1 Computing Devices 09

1.1.2 Basic Operations of A Computer 10

1.1.3 Classification of Digital Computers 10

1.1.4 Modern use of Computers in Today's Life 12

1.1.5 Computer Hardware and Software 13

Types of Computer Software 13

1.2.1 System Software 13

1.2.2 Application Software 15

1.2.3 Internet Applications 16

1.2.4 Licensed Software, Open Source Software, Shareware and Freeware ... 17

1.2.5 Firmware 17

1.2.6 Internet Application Security 18

1.3 Computer Hardware 18

1.3.1 Input Devices 18

1.3.2 Output Devices 22

CHAPTER 2 COMPUTER MEMORY 28

2.1 Introduction to Computer Memory 28

2.1.1 Memory characteristics 29

2.1.2 Memory Terminology 29

2.1.3 Memory Built-up and Retention power 30

2.1.4 Types of Computer Memory 32

Main Memory 32

2.2.1 Internal Processor Memory 33

2.2.2 RAM (Random Access Memory) 33

2.2.3 ROM (Read Only Memory 34

2.3 Secondary Memory 35

2.3.1 Secondary Storage Devices 35

2.3.2 Sequential Access and Direct Access Memory Devices 35

2.3.3 Types of Secondary Storage Devices 36

CHAPTER 3 CENTRAL PROCESSING UNIT 42

Inside CPU 42

3.1.1 Components of CPU 43
3.1.2 Registers 45
3.1.3 Buses 46
CPU Operations 47
3.2.1 Instructions 47
3.2.2 Instruction Formats 49
3.2.3 Instruction Cycle 50
3.2.4 CISC and RISC Architecture 51
3.2.5 INTEL and AMD Processors 51
CHAPTER 4 INSIDE SYSTEM UNIT 56
4.1 Computer Casing and System Unit 56
4.1.1 CPU and System Unit 57
4.1.2 Computer Casings 57
4.1.3 Exploring the System Unit 57
4.2 Ports, Expansion Cards and Memory Chips 60
4.2.1 Ports and Their Types 60
4.2.2 Types of Expansion Cards 62
4.2.3 Memory Chips 64
CHAPTER 5 NETWORK COMMUNICATION AND PROTOCOLS 68
Network Communication 69
5.1.1 Basic Network Communication Components 69
5.1.2 Modes of Network Communication 71
5.1.3 Communication Media 73
5.1.4 Communication Devices 75
5.1.5 Network Architecture 77
5.1.6 Types of Networks 78
5.1.7 Network Topologies 80
Data Communication Standards 82
5.2.1 Purpose of Communication Standards 82
5.2.2 OSI Model 82
5.2.3 Protocols and Devices Used at Various Layers of OSI Model 84
TCP/IP 84
5.3.1 TCP/IP Protocol 84
5.3.2 TCP/IP and OSI Model Comparison 85
5.3.3 Circuit Switching and Packet Switching Networks 86
5.3.4 IP Addressing Schemes 86

CHAPTER 6 WIRELESS COMMUNICATIONS 92
6.1 Introduction 92
6.1.1 Wireless Networks 93
6.1.2 Advantages and Disadvantages of Wireless Networks 94
6.1.3 Radio Signal 95
6.1.4 Radio Transceiver 95
6.1.5 Wireless Access Point (WAP) 95
6.1.6 Line of sight communication 96
6.1.7 Short and Long Distance Wireless Communications 96
6.2 Short Distance Wireless Communication 97
6.2.1 Wi-Fi 97
6.2.2 Wi-Max 97
6.2.3 Bluetooth 97
6.2.4 Infra-Red 98
6.3 Long Distance Wireless Communication 98
6.3.1 Cellular Communication 98
6.3.2 Global Positioning System 98
6.3.3 Classification of Satellite Communication 99
6.4 Mobile Device Communication 100
6.4.1 Requirements of Mobile Communication 100
6.4.2 Architecture for Communication Over Mobile Devices 101
6.4.3 Limitations of Mobile Communication Systems 102
CHAPTER 7 DATABASE FUNDAMENTALS 106
7.1 Introduction to Database 107
7.1.1 Data and Information 107
7.1.2 File Management System 107
7.1.3 Database Approach 108
7.1.4 Database Management System (DBMS) 108
7.1.5 Advantages of DBMS Over File Management System 109
7.1.6 Role of Database Administrator (DBA) 110
7.1.7 Database Models 110
7.1.8 Database Languages 112
7.2 Database Terminologies 113
7.3 Planning A Database 115
7.4 Data Modeling and Entity-Relationship Diagram 117
7.4.1 Data Modeling 117
7.4.2 Entity-Relationship (ER) Diagram 118

7.4.3 Cardinality and Modality 121
7.4.4 Entity- Relationship (ER) Diagram - Examples 123
7.4.5 Normalization of Relational Database 125
CHAPTER 8 DATABASE DEVELOPMENT 131
Introduction 131
8.1 Various Types of Database Management Systems 131
8.1 Selecting A Suitable DBMS 132
8.1 Creating and Saving an Access Database 134
8.1.4 Database Objects 135
8.2 Working with Tables 135
8.2.1 Creating, Saving and Editing A Table 135
8.2.2 Data Types in Access 138
8.2.3 Creating Primary Key and Foreign Key 139
8.2.4 Creating and Editing Relationship between Tables 140
8.2.5 Navigating Through Records in A Table 142
8.2.6 Adding, Modifying and Deleting Records 143
8.3 Working with Forms 145
8.3.1 Creating, Saving and Editing a Form 145
8.3.2 Different Form Views 149
8.3.3 Navigating Through Records in a Form 149
8.3.4 Using Form to Add, Modify and Delete Records 150
8.3.5 Using Form Controls 150
8.4 Working with Queries and Commands 150
8.4.1 Different Ways of Creating, Saving and Editing Queries 150
8.4.2 Creating Queries 150
Generating Reports 157
8.5.1 Creating a Simple Report Using Report Wizard 157
8.5.2 Creating a Report Using a Query 160
8.5.3 Viewing and Printing Report 165
Answers to MCQs 170
Glossary 172
Abbreviation 178

1

OVERVIEW OF COMPUTER SYSTEM

After completing this lesson, you will be able to:

- Identify computing devices.
- Define the term computer and its basic operations.
- Define and classify types of computers (micro, mini, mainframe, supercomputer and mobile computing).
- Differentiate between hardware, software and firmware.
- Describe application software and system software.
- Define the terms licensed software, open source software, shareware and freeware.
- Define various input/output devices and understand their working principles.
- Differentiate between hardcopy and softcopy.

Reading

UNIT INTRODUCTION

Computer systems are now commonplace in every part of our life. This unit introduces the basic components that make up these computer systems. There are two parts to all computer systems; the hardware and the software. Hardware is the collective name given to all the devices that make up a computer system. Software is the term used for the actual programs that allow the hardware to do a useful job. Software is made up of a series of instructions that tell the computer what to do.

Teacher Point

1. Before starting the chapter, the students could be encouraged to explain what they understand about Computer system.
2. Teacher should explain the importance of Computer in daily life.

1.1 INTRODUCTION TO COMPUTERS

A computer is an electronic device that accepts data (as Input), performs operations (as Processing) on data at very high speed and produces the results (as Output). It is a programmable machine that executes a programmed list of instructions that it is provided.

Computers are composed of the central processing unit (CPU), input devices, output devices, secondary storage, and communication devices. The CPU is the main component of a computer that interprets and executes instructions.

A digital computer is a machine that can solve problems for people by carrying out instructions given to it. A digital computer consists of an interconnected system of processors, memories and input/output devices. A simple computer system is shown in Fig.1.1.

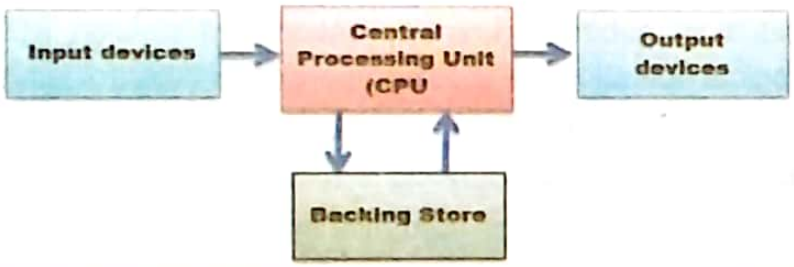


Fig.1.1 A simple computer system

TECHNOLOGY FACT!

Although we normally think of computers as the ones we use in our everyday lives to surf the web, write documents etc., small computers are also embedded into other things such as mobile phones, toys, microwaves and MP3 players. We use computers all the time, often without even knowing it!

1.1.1 COMPUTING DEVICES

All machines, components or devices that contain embedded, specialised computers are called computing devices. For example ATM machine, Digital alarm clock, Digital washing machine, Microwave oven, Toys, Cell phones, CD player, etc. are computing devices. All these

ATM Machine

Digital Washing Machine

Digital Microwave Oven

Electronic Toys

Cell Phones

Digital Clock

Fig.1.2 Computing Devices

devices contain embedded computer chips which allow these devices to do special computing tasks, for example the computer of ATM machine gives banking transactions facilities, the computer of Digital alarm clock sets the time for alarm and manages calendar, and the computer of Digital washing machine can be programmed to wash clothes. Some important computing devices are shown in Fig 1.2.

1.1.2 BASIC OPERATIONS OF A COMPUTER

Any computer system, regardless of its size, is capable of performing the following basic operations which are shown in Fig.1.3.

Input operation: Accepting data for processing from an input device.

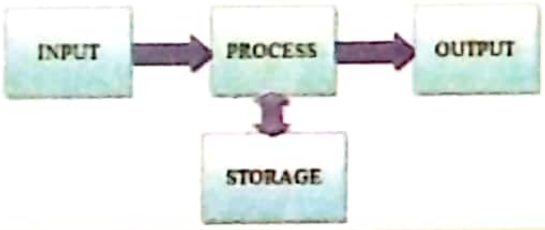


Fig.1.3 Basic operations of a computer

Processing operations: Performing arithmetic and logical operations. Arithmetic operations include addition, subtraction, multiplication and division while logical operations include comparison of different values and decision making.

Output operation: Sending results to an output device.

Storage operation: Writing data to a storage device such as hard disk or USB flash drive.

The purpose of a computer system is to accept data, process it and as a result of processing, produce output in the form of useful information. The input unit of computer presents data to the processor for processing. The results of processing of the data are displayed on the monitor screen, printed on paper or sent to any other output or storage device.

1.1.3 CLASSIFICATION OF DIGITAL COMPUTERS

There are several factors that make computers different from each other. These factors are physical size, cost, speed, etc. Based on these factors, computers are classified into four categories.

- Supercomputer
- Mainframe computer
- Minicomputer
- Microcomputer

DO YOU KNOW?
The first electro-mechanical computer was developed in 1939.
(Get more info from the Internet)

Supercomputer

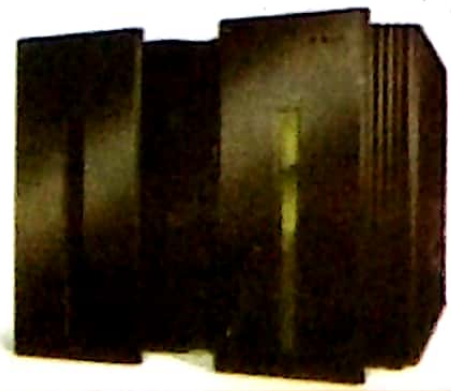


Fig.1.4 Modern Supercomputer

Supercomputers are the largest, the most expensive and powerful computers. They are used to process complex calculations as well as designing and controlling of complicated machines, such as rockets and fighter planes. Supercomputers are also used in nuclear research and weather forecasting which requires huge amount of calculations to be performed at high speed. The best known supercomputers are built by Cray Inc. an American supercomputers manufacturers and IBM. In Pakistan supercomputers are used in many organizations, like Atomic Energy Research Centre. A supercomputer is shown in Fig.1.4.

Mainframe computer

Fig. 1.5 Mainframe computer

These are larger, more expensive and more powerful computers compared to minicomputer but less powerful than supercomputer. They are used in large corporations, banks, universities and scientific laboratories. Mainframes usually fill a large room because they include many types of peripheral devices.

A typical mainframe can execute about trillion instructions per second (TIPS) and can support thousands of users.

Some examples of mainframe are IBM's zEnterprize EC12, EC 196 and HP 16500 Series.

A mainframe is shown in Fig.1.5.

Minicomputer

Fig.1.6 Minicomputer

These computers are larger and more expensive than microcomputers. Minicomputer and its peripheral equipment can usually fill a small room.

Minicomputers can support hundreds of users at a time. Minicomputers are faster than microcomputers. They can execute billions of instructions per second (BIPS). These computers can process more data than microcomputers.

Minicomputers are widely used in industrial process control, scientific research and small business applications.

Due to advancement of technology, the difference between the performance of microcomputer and minicomputer is gradually decreasing. As a result, modern microcomputers are replacing the more expensive minicomputers.

Examples of minicomputer are IBM System/36, DEC PDP, VAX Series, HP 3000, etc. A minicomputer is shown in Fig.1.6.

Microcomputers

Fig.1.7 Microcomputer

Microcomputer, shown in Fig.1.6, is the smallest and least expensive computer. Its small size is a result of LSI (Large Scale Integration) and VLSI (Very large Scale Integration) technologies. A modern microcomputer can execute millions of instructions per second (MIPS). Although, this is very fast but it is much slower than minicomputers and mainframes.

A typical microcomputer (as shown in Fig.1.7) consists of a Keyboard, a Mouse, a Monitor and System Unit. Microcomputers are used at home for personal use as well as for business applications. A large variety of software is

available for use on microcomputers. A microcomputer can easily fit on a desktop or in a briefcase in the form of laptop computer.

Some examples of microcomputer are IBM Thinkpad, Toshiba Satellite series, Dell XPS, HP Envy series and Apple series.

1.1.4 MODERN USE OF COMPUTERS IN TODAY'S LIFE

Mobile Computing

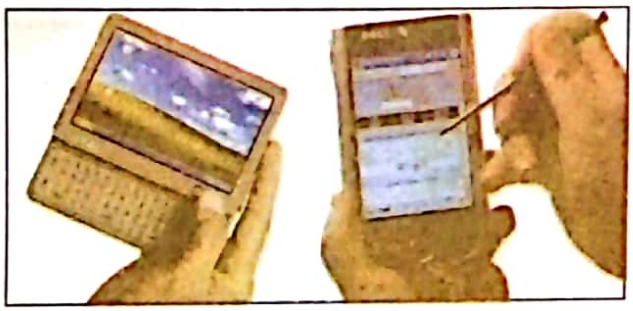


Fig.1.8 Tablet PC and PDA

It refers to a variety of small portable devices such as shown in Fig.1.8 that allow people to access data and information from anywhere in a wireless network system. Mobile computing devices run on batteries and have limited functionality as compared to laptops. Popular mobile computing devices are tablet PCs, PDAs (Personal Digital Assistants) and smartphones.

Internet of Things (IoT)

Internet of Things (IoT) is the interconnection between computer network and physical devices to collect and exchange data. Devices used in daily life can be equipped with wireless connectivity, and embedded with software, sensors, actuators, cameras, microphones and other instruments that enable them to collect and share data. All kinds of household items can be modified to work in an Internet of Things system. These device are known as smart devices and they are designed in such a way that they can interact with human beings through wireless connection.

Smart home is a popular application of IoT. In future, IoT will allow us to switch on air conditioning before reaching home or switch off lights after leaving home. There are homes equipped with various types of electronic devices that can be controlled remotely with smart phone or computer through IoT system.

Cloud Computing

Cloud computing means instead of buying and installing your own computer system and software at your workplace, you can get it as a service provided and managed by another company. You can perform your computing tasks through access to service over the Internet. It does not matter where the hardware and software is located. It is just somewhere in the "cloud". It is a way of outsourcing your computing requirements.

The advantage of cloud computing is that you don't have to buy and maintain a complex computer system. This cuts cost of buying computers and peripherals. Besides, you are not worried about equipment going out of date and other problems related with system security and reliability.

The disadvantage of cloud computing is that it requires a reliable high speed broadband connection functioning the whole time you are working. Another disadvantage of cloud computing is the privacy and security risk of having valuable data on someone else's system in an unknown location. Companies those offer Cloud Computing services are: Google, Microsoft, Ctrix Systems, Joyent and Amazon, etc.

Data Centers

Data center is a centralized location for collecting, storing, processing and distribution of vast amount of data. It consists of servers, routers, switches and backup equipment. A data center facility usually requires air conditioning, fire suppression, smoke detection and security entry. It may be housed in a room, an entire building or a group of buildings. Organizations such as government agencies, banks, educational institution, telecommunication companies and social networking services use large amount of data and thus have requirement for data center. Many companies are moving their data centers to cloud services to cut the cost of running their own computing networks and servers.

1.1.5 COMPUTER HARDWARE AND SOFTWARE

A computer system consists of hardware and software.

Hardware

All physical components of computer system, such as monitor, keyboard, hard disk, printer, along with the circuitry connecting them are known as computer hardware. Computer hardware is what you can physically touch and see. In simple words all tangible parts of computer system are referred as hardware.

Software

Software is any set of instructions, also called programs, which are given to the computer to perform any task or to do any activity. It tells the computer what to do and how to do. Programming languages are used to prepare software.

A computer cannot do anything on its own. It must be instructed to do a desired job. Hence, it is necessary to specify a sequence of instructions, which a computer must perform to solve a problem. For example, word-processing software, spreadsheet software and database management software may contain many programs for creating, editing, formatting and printing different types of documents.

1.2 TYPES OF COMPUTER SOFTWARE

Computer software can be classified into the following types.

- System Software
- Application Software
- Internet Applications
- Licensed Software, Open Source Software, Shareware and Freeware

1.2.1 SYSTEM SOFTWARE

System software is a collection of system programs that control and coordinate the activities of a computer system. System software consists of a collection of operative programs

Teacher Point

Students may be taken to some organizations like Electric supply companies, Sui gas companies, Airlines, etc., to show the working of different types of Computer systems, like Mini, Mainframe and Super computers.

required to control computer hardware and also to execute application software. The purpose of system software is to make the use of computer more effective and efficient. A computer without some kind of system software would be ineffective and impossible to operate. Some examples of system software are:

- Operating system
- Device Drivers
- Utility Software
- Language Processors/Translators

Operating System

Operating system manages the hardware and software resources of a computer system, such as CPU, storage devices and all the input/output devices. Some commonly used operating systems are Windows, Linux, Mac OS and Android.

Operating system performs the following tasks.

- Allocates system resources
- Manages files by maintaining a proper file and folder system
- Loads and executes application software
- Controls the operation of all the input/output devices
- Maintains security
- Controls network operations
- Provides user interface

Device Drivers

Device drivers are system software that controls the operation of hardware devices. When we attach any type of device, such as printer, scanner, network card, or digital camera to a computer, it will not work without a device driver. We have to first install the driver of a device in our computer before using it. Device drivers are provided by device manufacturers. Some devices like Mouse, Keyboard, Monitor, USB Flash drive, etc. are "***Plug n Play***" devices. Their software is preinstalled with Windows. When attached, the computer system automatically recognize them.

Utility Software

Utility software (or simply utilities) provides additional facilities to carry out tasks which are beyond the capabilities of the operating system. A few important utilities are disk defragmenter, disk cleaner, file compression utilities, antivirus utility, file manager, network utilities and utilities to configure hardware devices.

Teacher Point

Teacher should explain the importance software for computer.

Language Processors/Translators

The computer can only understand machine language which consists of 0's and 1's. Therefore, any program written in assembly language or high level language must be translated to machine language before execution by the computer. Language processors are used to translate computer programs into machine language. The types of language processors are assembler, compiler and interpreter.

Assembler is software that translates assembly language program into machine language. Assembly language consists of symbolic abbreviations called mnemonics which must be translated into machine language before execution by the computer. Each computer has its own assembly language.

Compiler is software that translates a program written in a high level language into machine language. It converts the entire program into machine language before execution by the computer.

Interpreter is software that translates high level language into machine language but it translates one instruction at a time and executes it immediately before translating the next instruction.

1.2.2 APPLICATION SOFTWARE

Application software is a set of programs designed to perform a specific task. For example, application software for payroll processing produces pay slips and application software for processing examination results produces mark sheets along with some other statistical reports.

Some examples of application software are:

- Productivity Software
- Business Software
- Entertainment Software
- Educational Software

Productivity Software

Productivity software is used to improve the way people do their work. It speeds up the daily routine tasks performed by individuals and teams by eliminating the repetitive tasks. Productivity software includes word-processing, spreadsheet, database management and graphics software.

Business Software

Business software is used to run business activities. It helps in efficiently running business functions of a company. Examples of business software are payroll, accounting, inventory and retail software.

Entertainment Software

Entertainment software is used to entertain people. It includes games, audio video player, etc.

Educational Software

Educational software is used for learning purpose. Examples of educational software are programs that teach about human body, working of an engine, solar system, typing, foreign language, music and subjects like Mathematics, Physics, Chemistry, etc.

1.2.3 INTERNET APPLICATIONS

- Web Applications
- Cloud Computing Applications
- Social Media Network Applications

Web Applications

A Web application is a program that runs on a remote server while its users interact with it through a Web browser. Some common Web applications include web-based email programs (such as Gmail, Hotmail), online ticketing service, on line banking service, online auction, online retail sales, instant messaging services, etc.

Cloud Computing Applications

Cloud application is a program that supports cloud computing. A cloud application is entirely stored on a remote server and is delivered over the Internet through a Web browser. Users of a cloud application need a computer with a high speed Internet connection.

Social Media Network Applications

Social media is an Internet-based communication system that allows the creation and exchange of information, ideas, common interests and other forms of expression. Social media websites connect users with their friends, family and colleagues through the use of Internet. Some popular examples of social media are Facebook, Twitter and WhatsApp.

Facebook: Facebook is one of the fastest growing free social networking services used by millions of people all over the world. It allows registered users to create profile and exchange messages, photos, videos and links with other users. It helps users stay updated with what is happening around the world. It provides a platform by which users can create groups and pages based on their common interests and share views and ideas.

Twitter: Twitter is an online news and social networking service which allows subscribers to broadcast short messages to other subscribers of the service. The short messages known as "tweets" are restricted to 140 characters. It is free to join service. It is totally different from email and more like a news broadcast. Users of Twitter service type short statements about what is going on in their life, what they are doing and what their thoughts and opinions are on specific topics or current affairs. People all over the world are continually broadcasting tweets which can be viewed by anyone.

WhatsApp: WhatsApp is a free instant messaging service for smartphone users to exchange text, photos, videos and audio messages through Internet. It has become the largest messaging service around the world. WhatsApp is very popular among teenagers because of features like group chatting, voice messages and location sharing. It was started for Android

mobile devices but now it is available for iPhone, BlackBerry, Windows Phone and Nokia smartphone also.

1.2.4 LICENSED SOFTWARE, OPEN SOURCE SOFTWARE, SHAREWARE AND FREEWARE

Licensed Software

A software license is a legal agreement that specifies the terms of use for a computer program. It defines the rights of the software developer and the user. When a person purchases software, he is allowed to use the software, which means he is not the owner of the software. Generally all the system software and application software is licensed.

The software license deals with the Copyright Law. Copyright law prevents illegal copying of computer software. It allows creators of computer software to benefit financially from their software and to retain some control over how it is used.

When the software is given away free, it makes it difficult for the software creators to stay in business. This makes it improper to make copies of software and sell it. Software that is copied and sold without the permission of the owner is known as pirated software and it is violation of copyright.

Examples of licensed software are Microsoft Windows and Microsoft Office.

Open Source Software

It is computer software that is available in the form of source code that allows users to study, change and improve it. Open source software is free for inspection, modification and distribution. It allows certain rights which are normally protected by Copyright Law. Linux operating system is an open source software.

Shareware/Trial-ware

Shareware is given to people free of charge for a limited time period. After the expiry time, this software should be purchased for further usage. Shareware is a trial version and its functionality is limited. There are some types of shareware which are available as full version but they stop working at the end of trial period. The trial period is usually 30 or 60 days. Some shareware can be downloaded from Internet. For examples some Antivirus software are shareware.

Freeware

Freeware is available for use, free of cost. It is usualiy full version of the software for an unlimited period of time. This software may have restrictions in term of use. For example, it may be allowed for personal or academic use only or for non-profit use. Some examples of freeware are Skype, Viber and Mozilla Web browser.

1.2.5 FIRMWARE

Firmware is an intermediate form between hardware and software. It consists of software embedded in electronic devices during their manufacturing. Firmware is used when the programs are rarely or never expected to be changed, for example, in toys, appliances and ROM. Firmware is also used when the programs must not be lost when the power is off.

1.2.6 INTERNET APPLICATION SECURITY

Internet application security refers to preventive measures against threads that can harm the Internet applications. Internet applications are available 24/7 and offer access to many people leading to high risk of intrusion. Internet applications are venerable to a wide variety of threats. Hackers can steal, modify or delete sensitive data. To ensure application security, it is essential to continuously monitor the activity of server on which the application is running and block hackers trying to obtain sensitive data. Internet application security system consists of firewalls, anti-virus programs, spyware detection and removal programs and encryption/decryption programs.

1.3 COMPUTER HARDWARE

A computer system consists of hardware and software. The physical components of a computer that we can see, touch and feel are called hardware. Computer hardware consists of input devices, output devices, memory devices, processing devices, communication devices and the electronic circuitry that links these devices for communication between them. In this section only input and output devices are discussed. Other devices will be covered in the coming units.

1.3.1 INPUT DEVICES

The input devices are used to communicate with the computer. They consist of devices that accept data and convert it into machine readable form. These devices are often referred to as peripherals because they are physically separated from the system unit. Some input devices are keyboard, mouse, joystick, microphone and image scanners.

Keyboard

Keyboard is the primary input device for the input of data to a computer, though voice input devices may ultimately supersede it. It operates by converting key presses to electronic signals in digital form. Keyboard has the standard character keys together with numeric keys and special keys.

Pointing Input Devices

Pointing devices are used to control the movement of the pointer (cursor) to select items on a screen or open computer programs or files.

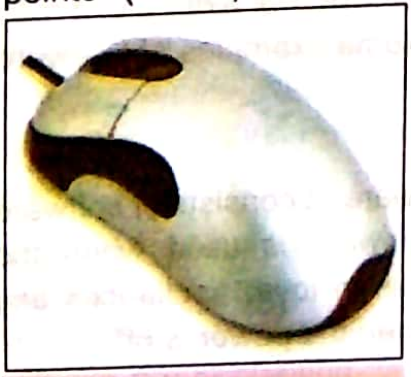


Fig.1.9 Mouse

Commonly used pointing devices are mouse, trackball, joystick, touch screen, light pen and touch pad.

DO YOU KNOW?
The First Computer Mouse was invented by Doug Engelbart in around 1964 and was made of wood.

- **Mouse**

Mouse is a hand-held pointing input device that detects multi-dimensional motion relative to a surface. This motion is typically translated into the motion of a pointer on a display screen, which

allows a smooth control of the objects on the screen. Mouse originally used a ball rolling on a surface to detect motion, but modern mouse has optical sensors that have no moving parts. In addition to moving a cursor, mouse has one or more buttons to allow operations such as selection, scrolling, dragging, etc. Mouse is an essential part of the computer system to run/use Windows and other application software. A Mouse is shown in Fig.1.9.

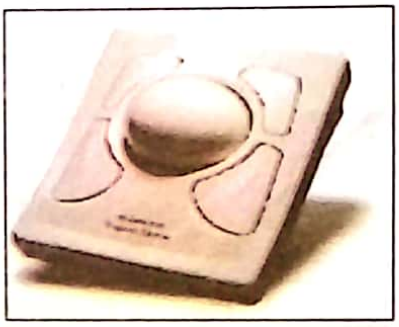


Fig.1.10 Trackball

- **Trackball**

Trackball remains stationary on the surface. The ball, at the top, is rolled with fingers. It has buttons that are used to perform operations similar to those performed by a mouse. A trackball is shown in Fig.1.10.

- **Joystick**

Joystick is commonly used for playing computer games. It is fixed on the table and it has a stick in the centre that can be tilted in any direction. The stick is held by hand and when it is tilted in any direction, the movement is translated into the movement of an object on the screen. The buttons are used to perform actions such as firing guns and lasers. A joystick is shown in Fig.1.11.

Fig.1.11 Joystick

- **Touch Screen**

A touch screen is a computer display screen. It is an input as well as output device. The screen is sensitive to pressure. User interacts with the computer by touching pictures or words on the screen as shown in Fig.1.12. Instead of using a pointing device user can use finger to point directly to objects on the screen. Touch screens are generally attached to computers but they are also popular in other devices such as mobile phones, satellite navigators and Personal Digital Assistants (PDAs).

Fig.1.12 Touch Screen Monitor

- **Light Pen**

It looks like a pen with a photocell at its tip as shown in Fig.1.13. It is used to point to an object or draw

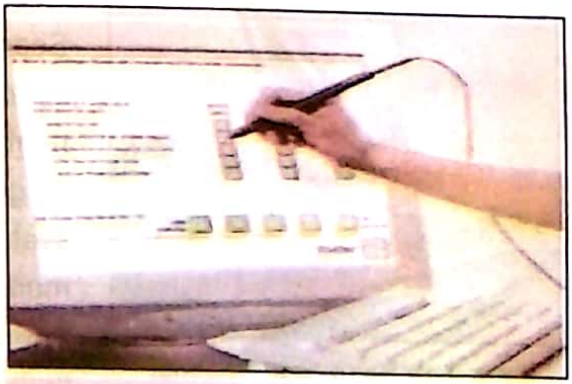


Fig.1.13 Light Pen

on the screen. It gives more accuracy than pointing with our finger on the touch screen. It is mainly used in engineering for designing purpose.

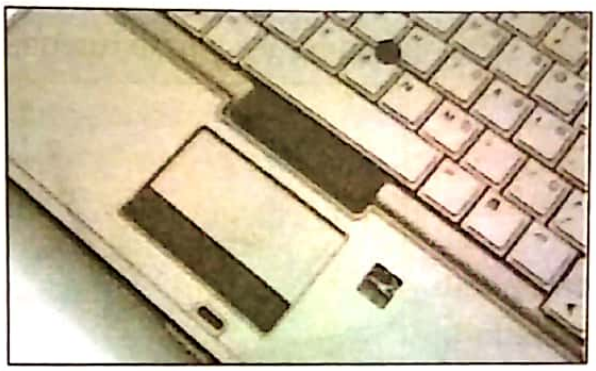


Fig.1.14 Touch Pad

- **Touch Pad**

Touch pad is used in laptop computers as shown in Fig.1.14. It is a pointing device that can sense the movement and position of finger on the pad. They are commonly used as an alternate to computer mouse in a laptop computer. There are two buttons located above or below the pad and their function is the same as the buttons on the mouse.

Fig.1.15 Microphone

Microphone

Microphone is used to convert the spoken words to digital signals for computer input. It converts audio signals to electrical waves and these are converted by electronic circuitry in the computer to digital form. A microphone is shown in Fig.1.15.

Digital Camera

It is a camera that captures pictures and stores them in digital form. Pictures taken by a digital camera can be downloaded to a computer for viewing and editing.

Fig.1.16 Digital Camera

Digital cameras have a LCD for viewing both images in the viewfinder and those in the camera's memory. It is an input as well as output device. A digital camera is shown in Fig.1.16.

Fig.1.18 Hand-held Scanner

Scanners

Scanner is an optical input device that optically scans printed or handwritten text and images and stores them in computer memory in digital form. Nowadays, scanners are widely used to get drawings, diagrams and photographs into computer systems for incorporation into documents and books which are made up electronically prior to printing.

There are different types of scanners like hand-held scanner, flatbed scanner and barcode reader.

- **Hand-held Scanner**

To scan an image, the hand-held scanner is dragged over the image to be scanned. The hand-held scanner should be moved carefully with uniform speed because uneven scanning rate would produce distorted image. Hand-held scanners are very useful for scanning articles from magazine, newspapers and books. A hand-held scanner is shown is Fig.1.18

Fig.1.19 Flatbed Scanner

- **Flatbed Scanner**

In a flatbed scanner, the image to be scanned is placed face down on the glass and a cover is lowered over it to exclude light. The camera moves across glass pane, reading the entire area. A flatbed scanner is shown in Fig.1.19.

- **Barcode Reader**

Barcode reader is also a type of scanner which is used to scan barcode, also called ***UPC*** (Universal Product Code), available on various products. These barcodes contain information about the product like name of the product, company, manufacturing date, expiry date, etc. This information is provided to the computer for further processing like generating bills at check outs in shopping malls. Prices are normally not included in barcodes because prices are not constant and may change frequently. A Barcode with reader is shown in Fig 1.20.

Fig.1.20 Barcode with Reader

Magnetic Stripe Card Reader

A magnetic stripe card reader is an input device that reads the information encoded in the magnetic stripe located on the back of a plastic card. Data is stored in the magnetic stripe in the form of tiny magnetized particles. The information on the card is read by swiping the card past a magnetic reading head. Examples of these cards include credit cards, ATM cards, VISA and MasterCard, driver's license and membership cards. A magnetic stripe card reader is shown is Fig.1.21.

Fig.1.21 Magnetic Stripe Card Reader

Teacher Point

Teacher may also use presentations or animations or videos to explain the working of I/O devices.

1.3.2 OUTPUT DEVICES

Output devices consist of computer components such as monitor, printer, speaker and plotter that transfer information from computer memory to the outside world. They display or print text, graphics or pictures. The output generated on paper by an output device such as printer or plotter is called ***Hardcopy*** output. The output in the form of data or information stored on a storage device or displayed on a monitor is called ***Softcopy*** output.

Monitors

A monitor, sometimes called a VDU (Visual display unit), is an electronic output device for computers. It displays the results of the user activities. The output produced by monitors is called softcopy output. There are different types and sizes of monitors, each can be distinguished on the basis of the following features:

Fig.1.22 CRT Monitor

Size: The size of the monitor is measured diagonally. Standard size of monitor is from 15 to 22 inches.

Color: The monitor can be either black and white or color.

Pixel: Pixel is a small/tiny dot on the monitor which forms the image.

Resolution: The number of pixels (or dots) per square inch is called the resolution of the monitor.

Dot Pitch: The distance between the pixels on the monitor is called dot pitch. The lesser the dot pitch more will be resolution of the monitor.

CRT (cathode ray tube), LCD (Liquid Crystal Display) and LED (Light emitting diodes) are the common types of monitors.

- **Cathode Ray Tubes (CRT) Monitors**

CRT monitors are similar to the standard television sets because they contain Cathode Ray Tube. The Cathode Ray Tube (CRT) is a vacuum tube containing an electron gun and a phosphors coated screen. The electron gun, fires a beam of electrons which falls repeatedly on the phosphors coated screen and it glows for a fraction of a second. In color CRT monitors there are three electron guns while the phosphors atoms are in three different colors i.e. Red, Green, Blue (RGB). Other colors are produced by the combinations of these three colors.

Fig.1.23 LCD Monitor

- **Liquid crystal display (LCD) Monitors**

Liquid Crystal Display (LCD) is a thin and light weight monitor. It contains a substance called liquid crystal between two sheets. The molecules of this substance are lined up in such a way that the light behind the screen is blocked or allowed to create an image on the screen. LCDs provide a sharper image than CRT monitors and emit less radiation. They are used in a wide range of

applications, including computer monitors, televisions, and clocks. They are usually more compact, lightweight, portable, less expensive, more reliable, and easier on the eyes than CRT monitors.

- **Light emitting diodes (LED) Monitors**

LED monitor is a light-weight flat panel display unit, which uses LEDs (light-emitting diodes) as pixels for display. In contrast to LCDs these monitors produce bright images and emit less radiations. LEDs run at lower temperatures and consume less power as compare to LCDs. Their lifespan is also longer than other types of monitors. The only drawback is that these monitors are expensive than other types of monitors.

Printers

Printers are used to produce hardcopy of output. In the past, printers were connected to the computer through parallel port but now they are connected through USB port.

Printers vary in their capabilities based on the following characteristics.

- The quality of output
- The ability to print graphics
- The printing speed

There are two main categories of printers.

- Impact printers
- Non-impact printers

- **Impact Printers**

Impact printers are those printers which work like typewriters. Impact printers use electro-mechanical mechanism, which causes the character shape to strike against the paper and leave an image of character on the paper. Examples of impact printers are dot matrix and chain printers. Their print quality is low and they produce noise.

Dot matrix printers have 9 or 24 pins arranged in a matrix to print shapes of characters. A dot matrix printer is shown in Fig.1.24.

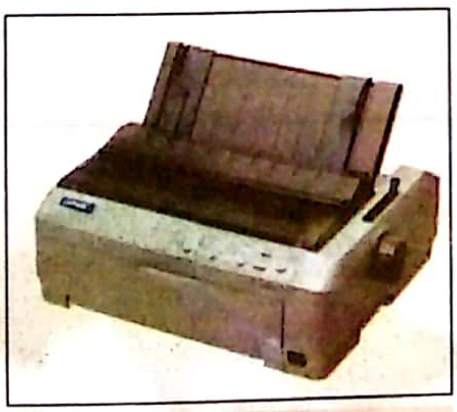


Fig.1.24 Dot Matrix Printer

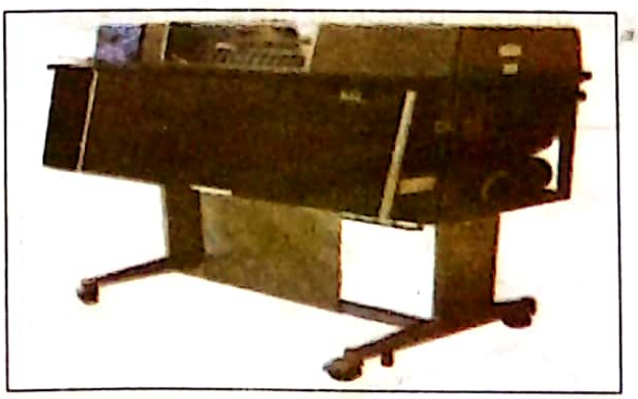


Fig. 1.25 IBM 1403 Chain Printer

Chain printer is very old type of line printer. It contains characters in a chain. The chain moves rapidly by two geared pulleys while printing. IBM 1403 Chain printer is shown in Fig.1.25.

- **Non-impact Printers**

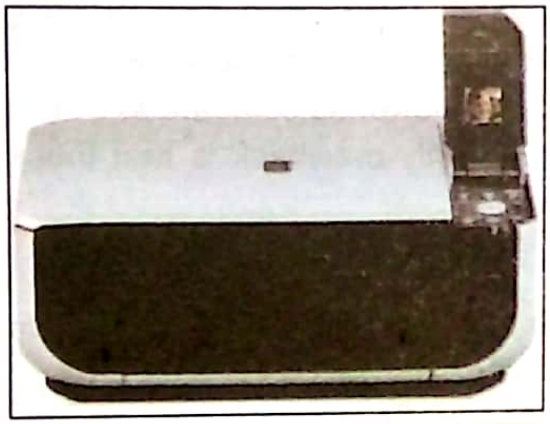


Fig.1.26 Inkjet Printer

Non-impact printers produce a printed image without striking the paper. The printing quality and speed of these printers is better than impact printers. These printers produce very little noise while printing. Commonly used non-impact printers are inkjet and laser printers. Inkjet printers are character printers. They form characters and all kinds of images by spraying small drops of ink on the paper. Inkjet printers are cheap, quiet in operations and can print in multicolour but the printing quality and speed is slower than laser printers. An inkjet printer is shown in Fig.1.26.

Fig.1.27 Laser Jet Printer.

Laser printers are page printers, meaning that they print an entire page at a time. Their printing technology is very similar to photocopiers. They are very fast and silent in operation. The print quality of laser printer is very high and they can print graphics in multicolour. A laser printer is shown in Fig.1.27.

Plotters

Plotters are output device used to produce large size hardcopy output. Plotters are used for a variety of applications, which include drawing graphs, making maps, plotting civil engineering drawings/machine components and producing large size panaflexes. Plotters are of two types i.e. flatbed and drum.

- **Flatbed Plotter**

Flatbed plotter plots on paper that is spread and fixed over a rectangular flatbed as shown in Fig.1.28. Pens of different colours are mounted in the pen holding mechanism that moves on the surface to draw the image.

Fig.1.28 Flatbed plotter

Fig.1.29 Drum Plotter

- **Drum Plotter**

In drum plotter, paper/sheet is fed from one side and drum of the plotter rotates to move the paper to the other side. These plotters are used to print large size of panaflexes as shown in Fig.1.29.

- **Speakers**

Speakers are audio output devices that are attached to the sound card on motherboard. Speakers produce softcopy output in the form of voice. Speakers are available in different shapes and sizes as shown in Fig.1.30.

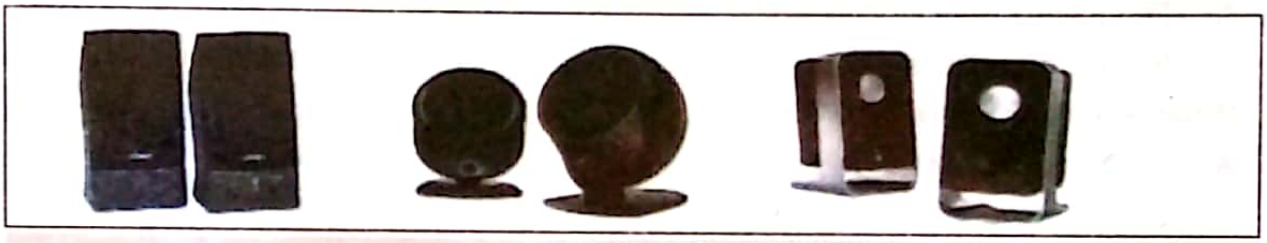


Fig. 1.30 Speakers

Key Points

- A computer is a device which takes instructions and data in the form of input, performs computations according to the given instructions and provides output as a result.
- All machines, components or devices that mediate in the processing of a computer system are called computer devices.
- Computers are classified into Microcomputer, Minicomputer, Mainframe and supercomputer. Microcomputers are the smallest and the least expensive computers whereas Supercomputers are the largest, the most expensive and powerful computers.
- The physical components of a computer such as monitor, keyboard and hard disk are known as hardware.
- System software is a collection of programs to make the use of computer easy, efficient and effective.
- Application software is a set of programs designed to perform a particular task.
- Firmware is an intermediate form between hardware and software which consists of software embedded in electronic devices during their manufacture.
- Input devices are used to communicate with the computer. They accept data and instructions from the user and convert them into machine readable form before storing in the computer memory.
- Output devices consist of peripheral devices that transfer information from the main memory to the outside world in human readable form.
- Hardcopy is the output generated on paper by an output device such as printer or plotter.
- Softcopy is data or information stored on a storage device or displayed on a monitor.

Exercise

Q1. Select the best answer for the following MCQs.

i. _____ of the following is the smallest computer.
   A. Mainframe
   B. Minicomputer
   C. Microcomputer
   D. Supercomputer

ii. How many instructions per second a Minicomputer can execute?
   A. Thousands of instructions
   B. Millions of instructions
   C. Billions of instructions
   D. Above trillion instructions

iii. What type of software MS Word is?
   A. System software
   B. Application software
   C. Utility software
   D. Language processor

iv. _____device is most suitable for playing games.
   A. Mouse
   B. Keyboard
   C. Joystick
   D. Light pen

v. Which of the following is an impact printer?
   A. Dot matrix printer
   B. Laser printer
   B. Ink jet printer
   D. Plotter

vi. _____ Software controls the operation of a hardware device.
   A. Utility software
   B. Language processor
   C. Application software
   D. Device driver

vii. Which of the following devices is used to print large size hardcopy?
   A. Plotter
   B. Inkjet printer
   C. Laser printer
   D. Chain printer

viii. Which of the following devices converts spoken words into electrical form?
   A. Touch pad
   B. Microphone
   C. Scanner
   D. Digital Camera

ix. _____ Software converts computer programs to machine language.
   A. Utility program
   B. Device driver
   C. Language processor
   D. Application software

x. Which of the following is productivity software?
   A. Spreadsheet software
   B. Utility software
   C. Windows 7
   D. Compiler

Q2. Answer the following questions briefly.

i. Give important characteristics of computers.
ii. Compare microcomputer with mainframe computer.

iii. Give few application areas of supercomputers.
iv. Name few organizations of Pakistan where Supercomputers are used.
v. How barcode system works in a shopping mall?
vi. Differentiate between computer hardware and software.
vii. Differentiate between system software and application software.
viii. Define licensed software.
ix. Differentiate between shareware and freeware.
x. Briefly describe magnetic stripe card.
xi. Give any five advantages of using LCD monitor over CRT monitor?
xii. Why LED monitors are better choice for LCDs? Give three reasons to support your answer.
xiii. Why dot-matrix printers are becoming obsolete?
xiv. What are the advantages of using laser printer over dot matrix printer?
xv. Give any three uses of plotters.

Q3. Answers the following questions.

i. Describe the types of system software.
ii. Why scanners are used? Describe their types.
iii. What are output devices? Explain its types.
iv. Why plotters are used? Briefly explain their types.
v. What is non-impact printer? Describe its types.

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. The assembling and disassembling of the computer system should be demonstrated to the student. (Practically or through some video/animation)
2. Students should be shown microprocessor, motherboard and power supply unit and the function of these should be explained through video/animation.
3. All the input/output devices covered in this unit should be shown to the students and their operations should be demonstrated.
4. The concept of "Plug n Play" devices should be demonstrated/explained practically by attaching such devices.
5. Hardcopies of various printers and plotters should be shown to the students for comparing print quality.
6. Students may be taken to the places/organizations where Super, Mainframe and Mini computers are used.
7. Teacher may ask the students to use the website www.howstuffworks.com for learning purpose.

2

COMPUTER MEMORY

After completing this lesson, you will be able to:

- Define bit, byte, memory word and memory units
- Differentiate between main memory and secondary memory
- Explain the difference between chip memory and magnetic memory
- Differentiate between volatile and non-volatile memory
- Describe internal processor memory, RAM and ROM
- Differentiate between sequential access and direct access memory
- Describe magnetic tapes, magnetic disks and optical disks
- Describe flash memory and memory cards

Reading

UNIT INTRODUCTION

Computer memory is one of the important and compulsory components of every computer system. This unit describes memory and memory devices used to store data and programs on a temporary or permanent basis for use in digital computers. The two main types of computer memories i.e. primary and secondary memories are discussed thoroughly.

2.1 INTRODUCTION TO COMPUTER MEMORY

In computing ***memory*** refers to the physical devices used to store programs (sequence of instructions) or data on a temporary or permanent basis for use in a computer or other digital/computing device. Memory in a digital computer contains the main part of operating system and all the application programs and related data that is being used.

Memory that communicates directly with the CPU as shown in Fig.2.1 is called ***main memory*** or primary

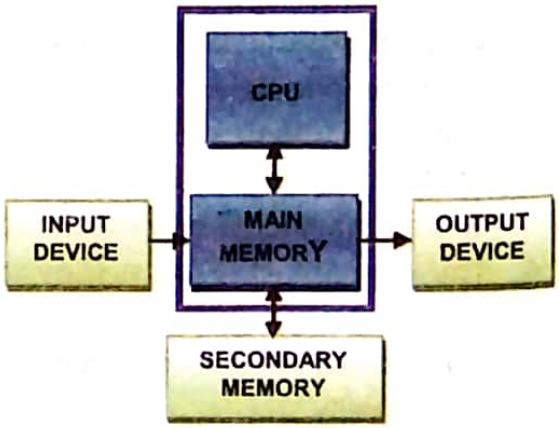


Fig. 2.1 Block diagram of a computer with memory unit

Teacher Point

Before starting the chapter, the students could be encouraged to explain what they understand about Computer Memory.

memory. Devices that provide backup storage are called ***secondary memory*** or mass storage devices. All the information is stored in secondary memory and it is transferred to main memory on a demand basis.

2.1.1 Memory characteristics

The important characteristics of any memory device are its access mode, access time, transfer rate, capacity and cost.

- ***Access mode:*** Memory has two major access modes, Sequential and Random. In Sequential access mode memory can be accessed only in serial order i.e. if we have to access 4th memory location then we first would have to move to first three locations and skip them and only then we can access the 4th location. It is also called serial access mode. In Random access mode memory location can be accessed at random i.e. if we have to access 4th location then we can directly go to 4th location and access it. It is also called direct access mode.
- ***Access time:*** It is the time taken to retrieve data from memory. Access time in sequential access memory devices is more than the random access memory devices.
- ***Data transfer rate:*** It is the time taken to transfer data from one memory device to the other. For example time taken to transfer data for Hard disk to the main memory (RAM).
- ***Capacity:*** The memory capacity is the amount of space that a memory device has to store data or the amount of memory required for a program to run.
- ***Cost:*** It is the price that computer users have to pay as per capacity of the memory device.

2.1.2 Memory Terminology

The following are some important memory terms related to memory.

Bit

The smallest unit of memory in digital computer is a bit, which stands for binary digit 0 or 1. The memory of a computer consists of millions of memory (or electronic) cells. Each cell contains one bit of information. The memory cell has two states, ON and OFF. The ON state represents a binary 1 and OFF state binary 0.

Byte

Byte is the basic unit of computer memory and it is the minimum piece of data to be processed by a computer. A group of 8 bits is known as one byte. One byte of memory is required to store one character in the computer, for example 'A', 'a', 'b', '*', etc. A byte is generally used to express the memory size of a computer. Computer memory is measured in terms of bytes. The higher units are Kilobyte (KB), Megabyte (MB), Gigabyte (GB) and Terabyte (TB). In future, memories will also be available in Petabyte (PB) and Exabyte (EB)

as indicated in red colour in Table 2.1. The relationship between the memory units is shown in Table 2.1.

MEMORY UNIT	EQUIVALENT TO
1 Byte	8 Bits
1 Kilobyte (KB)	2^{10} Bytes = 1024 Bytes
1 Megabyte (MB)	2^{20} Bytes = 1024 KB
1 Gigabyte (GB)	2^{30} Bytes = 1024 MB
1 Terabyte (TB)	2^{40} Bytes = 1024 GB
1 Petabyte (PB)	2^{50} Bytes = 1024 TB
1 Exabyte	2^{60} Bytes = 1024 PB

Table 2.1 Memory Units and their Equivalents

Memory Word

In computing, the smallest chunk or size of data that a computer can process is called memory word. It is a fixed-sized piece of data handled as a unit by the processor. The number of bits in a word is called the word size. Word size in modern computers typically ranges from 16 to 64 bits, depending on the size of the computer. A computer that has a bigger word size can transfer more bits into the microprocessor at a time for processing and this improves the processing speed of the computer.

The main indication of the word size is how much memory the processor can address. A 32-bit processor is limited to 2^{32} memory addresses. This is a group of bits (cells) in a memory that represents information or data of some type.

2.1.3 Memory Built-up and Retention power

All types of computer memories, as for as their built-up or manufacturing is concerned, are divided into Chip memory, Magnetic memory and Optical memory. And as far as their retention power is concerned these memories are divided into Volatile memory and Non-Volatile memory.

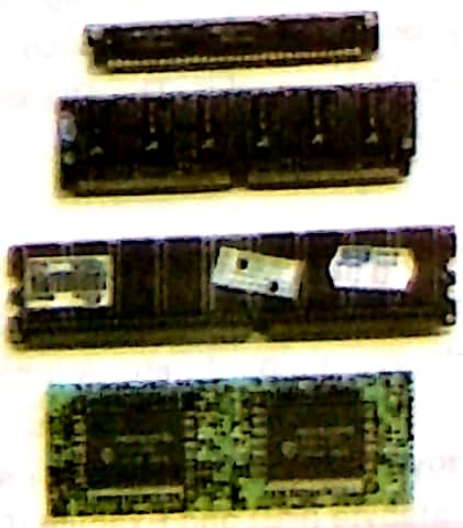


Fig.2.2: Chip Memory devices

Chip Memory

Chip is a small piece of semi-conducting material (usually silicon). A small circuit called IC (Integrated Circuit) is embedded on it. A typical chip contains millions of electronic components (transistors).

Chip memories are very fast as compared to other memories as there are no mechanical moving parts in them but on the other hand chips rely on electric currents.

Examples of chip memory are main memory (RAM, ROM and Cache), Flash memory drives, memory cards and registers. Many special-purpose chips, known as application-specific integrated circuits, are also being made today for automobiles, home appliances, telephones, and other devices. Different types of chip memory devices are shown in Fig.2.2.

Magnetic Memory

One of the most widely used types of digital data storage is magnetic memory/storage. This refers to any type of data storage using a magnetized medium. Magnetic tapes and disks are examples of magnetic memory devices. A thin layer of magnetic material is coated on the surface of magnetic tape and magnetic disks. Binary information is stored in the form of tiny magnetized and non-magnetized spots on the surface of magnetic tape or disk. A magnetized spot represents a binary 1 and a non-magnetized spot a binary 0. A read-write head moves very close to the magnetic surface. The head is able to detect and modify the magnetization of the material. Magnetic storage is widely used because it is relatively cheap in comparison with other storage technologies. The storage capacity is also very large, making it attractive for storing very large amounts of data. The major limitation of magnetic storage is that accessing the data can be quite slow. Hard disk is the common example of magnetic memory as shown in Fig 2.3.

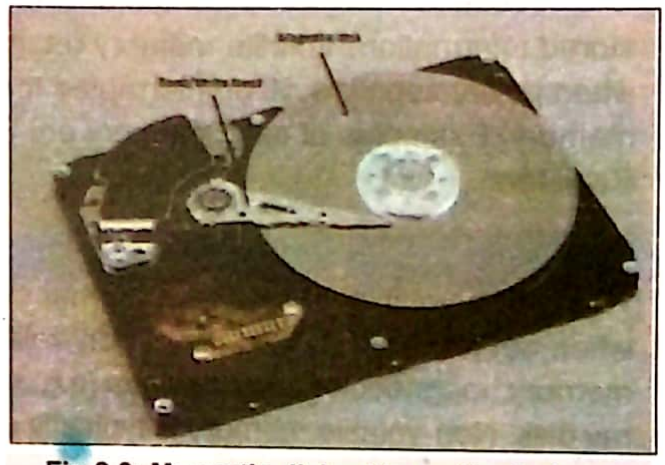


Fig.2.3: Magnetic disk with read/write head

Optical Memory

In optical-storage technology, a laser beam encodes digital data onto an optical disk in the form of tiny pits and lands arranged in concentric tracks on the disk's surface as shown in Fig. 2.4. A low-power laser scanner is used to "read" data or information from these pits and lands, and converts it to digital form.

Optical storage provides cheaper and greater memory capacity than magnetic storage. An entire set of encyclopedias, for example, can be stored on a standard 12-centimetre (4.72-inch) optical disk.

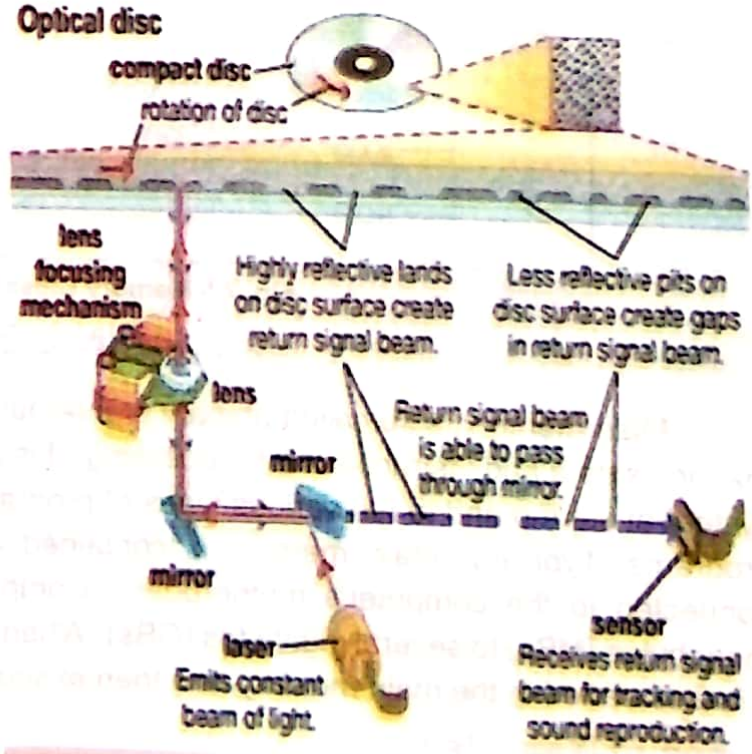


Fig.2.4: Optical Memory technology

Volatile and Non-Volatile Memory

Memory, on the basis of retention power, can be divided into two types i.e. volatile and non-volatile memory.

Volatile memory

Volatile memory is computer memory that requires power (electricity) to maintain the stored information. Volatile memory retains the information as long as power supply is on, but when power supply is off or interrupted the stored memory is lost. It is also known as temporary memory. Examples of such memory are RAM (Random access memory), Cache memory and Registers.

Non-Volatile memory

Non-volatile memory is a permanent memory that can retain the stored information even when not powered. Examples of non-volatile memory include ROM (Read-only memory), flash memory, magnetic storage devices (e.g. hard disks and magnetic tape), optical disks, and blue-ray disk. Non-volatile memory is typically used as secondary storage for long-term or future use.

2.1.4 TYPES OF COMPUTER MEMORY

Computer memory can be classified into two main types as shown in Fig. 2.5.

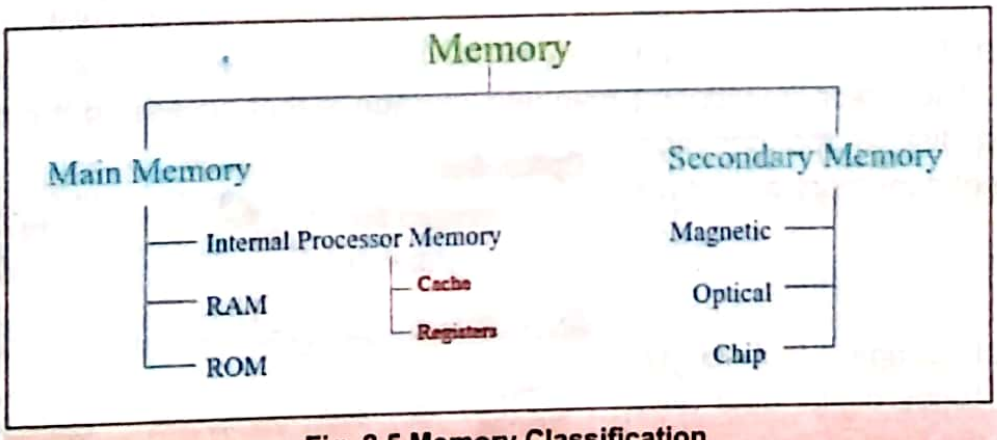


Fig. 2.5 Memory Classification

2.2 MAIN MEMORY

Main memory, also called primary or internal memory is the part of the computer system that holds data and instructions for processing. It is mainly used to store data that is used by the system at startup and to run various types of programs such as the operating system and other programs. Typically, Main memory is contained on microchips that are either attached or connected to the computer's motherboard. Computer memory can range from a couple of megabytes (MBs) to several gigabytes (GBs). When users load software from a storage medium, it is first loaded in the main memory and then executed or processed.

Types of Main Memory

Main memory is divided into the following three types.

- Internal Processor Memory

- RAM
- ROM

2.2.1 Internal Processor Memory

These memories are directly accessible to the CPU. Cache memory and processor registers are the examples of such memories. These are extremely fast memories.

Cache Memory

Cache memory is small amount of high-speed semiconductor memory which exists inside the microprocessor or on the motherboard of the computer. This memory stores some active portion of main memory. It lies between the RAM and the CPU. When any information is required by the CPU, first it will look up in the cache memory, and if it is not available in the cache then it will fetch it from the RAM.

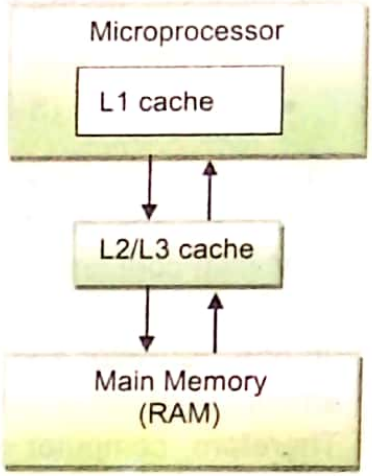


Fig.2.6 L1, L2 and L3 Cache Memory

There are three types of cache memories, Level 1(L1), Level 2(L2) and Level 3(L3) as shown is Fig.2.6.

L1 cache memory is built inside the microprocessor chip. It has the fastest access time.

L2 and L3 cache memories are separate chips on the motherboard. These can be accessed more quickly than the RAM.

Processor Registers

Registers are small memory units. There are a large number of registers inside the processor. There function is to temporarily store binary information and pass it on to the other parts of the processor or main memory during the execution of program instructions. Some commonly used registers inside the microprocessors are Accumulator (AC), Instruction register (IR), Data register (DR), Program counter (PC) and Memory address register (MAR).

2.2.2 RAM (Random Access Memory)

RAM stands for Random Access Memory. When the term RAM is used with semiconductor memories, it is usually taken to mean READ/WRITE memory. It is used in computers for the storage of active programs and data. The contents of RAM change continually as the computer executes a program. RAM plays very important role in the processing speed of the computer. Large RAM size provides larger amount of information to a computer for processing and hence increases the processing speed. The major disadvantage of RAM is that it is volatile and will lose all stored information if power is turned off.

DO YOU KNOW?
Robert H. Dennard invented first dynamic random-access memory (DRAM) in 1968.

Teacher Point

1. Teacher should explain the difference between memory and storage.

The following are the types of RAM

- Dynamic RAM (D-RAM)
- Static RAM (S-RAM)

Dynamic RAM (D-RAM)

Dynamic RAM (D-RAM) is the most common type of RAM in the computer. Each dynamic RAM chip contains millions of memory cells. A memory cell is an electronic switch, having two states, ON and OFF, representing binary 1 and 0 respectively. These memory cells are made up of a transistor and a capacitor. Each memory cell can store one bit of information. A small amount of power is put into the cell to store one bit of information. This energy leaks out quickly. Therefore, computer must recharge all the cells in the memory chip many times per second otherwise the information will be lost. It is used in computers as temporary memory (RAM). Normal RAM used in computers is D-RAM.

Static RAM (S-RAM)

Static RAM (S-RAM) works in a different way. Each memory cell of static RAM is like an electronic switch having two states, ON and OFF. ON state represents a binary 1 and OFF state a binary 0. It does not need to be recharged but it requires more transistors than dynamic RAM. It is faster than dynamic RAM and more expensive. Static RAM is used as cache memory in computers. S-RAM does need to the periodically refreshed. It operates at higher speed than D-RAM. S-RAM is expensive than D-RAM.

2.2.3 ROM (Read Only Memory)

ROM stands for Read Only Memory. The process of entering data in ROM is called programming the ROM. Some ROMs cannot have their data changed once they have been programmed; others can be erased and reprogrammed as often as required by the manufacturers. ROMs are used to store programs that are frequently required and are not to change during the operation of the computer. All ROMs are non-volatile because programs stored in them are not lost when the computer is turned off.

There are three types of ROM.

- PROM
- EPROM
- EEPROM

PROM

PROM stands for Programmable ROM. A PROM is a semiconductor chip that is obtained from the manufacturer in an un-programmed state and the user programs it according to his requirements. It can be programmed only once. PROM is used in electronic machine that require some information to be stored in it permanently.

EPROM

EPROM stands for Erasable PROM. This type of ROM can have its contents erased by ultraviolet light using special circuitry outside the computer and then reprogrammed. This procedure can be carried out many times. However, the constant erasing and rewriting will eventually make the chip useless. EPROMs are generally used for programs designed for repeated use such as the BIOS (Basic Input Output Setup) and can also be upgraded with a latest version of the program.

EEPROM

EEPROM stands for Electrically Erasable PROM. EPROM is also being used for ROM applications. The EEPROM can be altered while being used in a logic board by using special power circuits and write pulse generators. The EEPROM can work like a read/write semiconductor memory while retaining the non-volatile nature of ROMs and PROMs. This type of ROM works in a similar way to flash memory. It is used to store a computer system's BIOS and can be updated without removing it from the circuit board.

2.3 SECONDARY MEMORY

Secondary memory is also known as backing storage, auxiliary storage or mass storage. It stores large amount of information permanently. Some examples of secondary storage devices are Hard Disk drive, CD, DVD, Blue Ray Disk, Flash memory and Memory cards.

2.3.1 SECONDARY STORAGE DEVICES

Secondary storage devices are used to store information even when the computer is turned off. All the secondary storage devices are non-volatile memory. The types of secondary storage devices used in modern computers are hard disks, CDs, DVDs, USB flash drives and memory cards. An internal hard disk is almost compulsory part of every computer system. Other secondary storage devices are portable.

2.3.2 SEQUENTIAL ACCESS AND DIRECT ACCESS MEMORY DEVICES

Memory devices are classified into sequential access memory and direct access memory devices, based on the access mode.

Sequential Access Memory

It is a type of memory in which data is accessed sequentially one after the other. A particular stored data is found by sequencing through all locations until the desired data is reached. This produces access times, which are much longer than those of direct access memories. Examples of sequential access memory devices include magnetic tapes and audio/video tapes.

Teacher Point

Teacher may also use presentations or animations or videos to explain the working of memory devices.

Direct Access Memory

In this type of memory the data is accessed directly or randomly. Semiconducto memories, disk memories and optical memories are direct access memories. Direct acces memory is also known as random access memory. Hard disk, compact disk and flash memor are examples of direct access memory.

2.3.3 TYPES OF SECONDARY STORAGE DEVICES

Secondary storage devices are classified into the following types.

- Magnetic Tape
- Magnetic Disks
- Optical Disks
- Chip Memory

Magnetic Tape

Magnetic tape is a plastic strip with a magnetic coated material. Bits are recorded as magnetic spots on the tape along several tracks. Usually 7 or 9 bits are recorded simultaneously to form a character. Read/write heads are mounted one in each track so that data can be recorded and read as a sequence of characters. Magnetic tape is either in the form of cassette or big reels as shown in Fig.2.7.

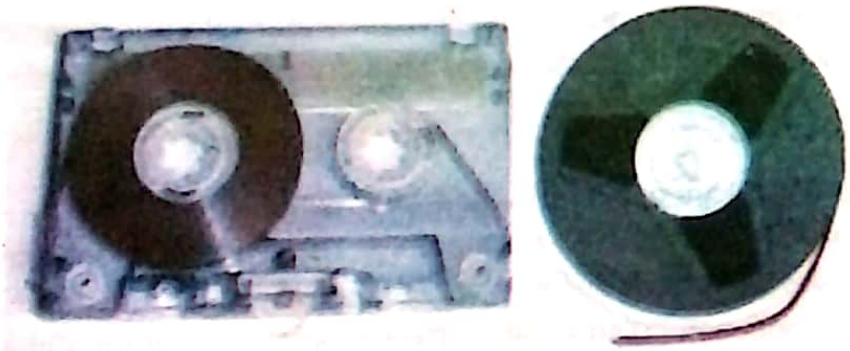


Fig.2.7 Magnetic Tape Cassette and Reel

Magnetic tape is slow in operation as it has sequential access to data but it is a cheap storage device. Magnetic tape drive is used to write data to and read data from a magnetic tape. Tapes are used for storing large amount of data. Modern tapes can store data up to 5 TB. It is used with minicomputers and mainframes for backups and archives.

Magnetic Disks

A magnetic disk is a flat disk coated with a magnetic material on which data/information is stored in digital form. Data/Information is stored in digital form in the shape of tiny magnetized spots called bits. Hard disk is the common type of magnetic disk in use today. Some other types of magnetic disks were also used in the past like Floppy disks and Zip disks. These disks are obsolete and not in use now days. These disks have been replaced by optical disks and USB flash drives which are more reliable and have more storage capacity.

The only magnetic disk used now days is the Hard disk.

Hard Disk

Hard disk contains one or many platters (disks) coated with magnetic material on both sides. The platters are attached to a spindle holding them in parallel with equal gap. All the platters rotate together at high speed. Bits are stored on the magnetic surface in spots along concentric circles called tracks. Hard disks contain thousands of tracks. Track is divided into sections called sectors. Each platter has two read/write heads for writing data to and reading data from both surfaces of the platter.

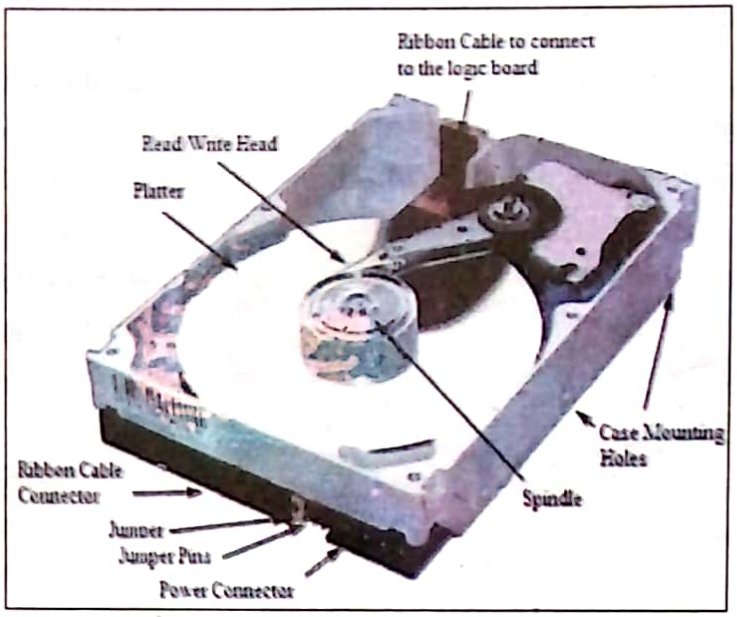


Fig.2.8 Hard Disk

Hard disks are manufactured in very clean environment. They must be kept dust free. Dust particles can create scratches on the surface of the platters and damage the data stored in it. The storage capacity of modern hard disks is in Tera bytes. A hard disk is shown in Fig.2.8.

Portable Hard Drive

A portable hard drive is a compact magnetic disk drive that plugs into a USB port on a computer. It is used as portable secondary or backup storage device. Its common storage capacity may range from 500GB to 4TB. It consists of one or more platters which are air-sealed inside a casing and connected to and powered by USB port of computer. It is used for storing data, programs, photos, music, videos and documents. New models are using USB 3.0 technology which provides fast file transfer rate. Some portable hard drives contain built-in wireless functionality to communicate with the computer through Wi-Fi connection. A portable hard drive is shown in Fig.2.9.

Fig.2.9 Portable Hard Drive

Optical Disks

Optical disk is a plastic-coated disk that can store digital data. Data is stored in optical disk in digital form by laser technology as tiny bumps etched on the surface.

The following are types of optical disks.

- CDs
- DVDs
- Blu-ray Disk

DO YOU KNOW?

In September 1956 IBM launched the 305 RAMAC, the first 'SUPER' computer with a hard disk drive (HDD). The HDD weighed over a ton and stored 5 MB of data.

Compact Disks (CDs)

It is an optical disk used for storing digital data. It was originally developed for storing and playback of sound recording but later on its use expanded to computer data storage. A CD is 1.2 millimeters thick with a diameter of 120 millimeters. It is made up of polycarbonate plastic and weighs 15 to 20 grams. The storage capacity of CDs ranges from 350 MB to 800MB.

Fig.2.11 A CD inside a CD Player

CDs are popular for storing data, application programs, device drivers, Windows operating system, images and videos. A CD has a single spiral track that spirals (rotates) from the center to the outside edge. Information is stored on a CD in the form of lands and bumps. A binary 0 is represented by a bump and a 1 by a land.

A CD drive/player is used for reading the data stored on the CD as shown in Fig.2.11. The job of CD player is to focus the laser on the track of bumps. The laser beam passes through the polycarbonate layer, reflects off the aluminium layer and hits the censor that detects changes in light. The bump scatters the light and the land reflects it into the censor. The change in reflectivity is transmitted as 0s and 1s into the memory of the computer.

Digital Video/Versatile Disks (DVDs)

DVD is very similar to CD but has larger data storage capacity. Its data storage capacity is about seven times more than CD. It has replaced the video tapes that were used in the past for storing movies. A DVD writer or player is used to read the data stored on a DVD. DVD players are compatible with CD which means they can play CDs also.

Fig.2.12 Blu-ray Disk

DVDs have the same diameter and thickness as CDs and are made of the same material and manufacturing methods. Data is also stored just like a CD on a spiral track in the form of lands and bumps. The storage capacity of DVDs ranges from 2GB to 16 GB. The MPEG (Moving Picture Experts Group) format is used for storing movies in a compressed form on the DVDs.

Teacher Point

Teacher should give some home assignments to the students at the end of the chapter.

Blu-ray Disk (BD)

Blu-ray is a new type of optical storage device. Its main advantage over CD and DVD is that it has storage capacity up to 300GB and it is also faster. The bumps on the surface of Blu-ray that represent digital information are much smaller and very densely packed compared to DVD. This increased the storage capacity of Blu-ray. Blu-ray disks are better storage devices for storing movies because they require a lot more storage. Another advantage of Blu-ray disk is their durability. They have a special coating that helps prevent scratches and marks. A Blu-ray disk is shown in Fig.2.12.

FLASH MEMORY/CHIP MEMORY

Flash memory or Chip memory is a type of EEPROM. It is solid-state storage device which means that there are no moving parts in it. Everything inside the flash or chip memory is in electronic form. It got its name "Flash" from the fact that it can store chunks of data and also erase large chunks of data in a flash because it is a semiconductor IC chip memory.

Flash memory comes in two forms, that is, in the form of flash drive and memory cards.

Flash Drive

Flash drives are also called USB flash drives. They are small and portable drives that are connected to computers through USB ports. The storage capacity of flash memory ranges from 2GB to 256GB. Flash drives are shown in Fig.2.13.

Fig.2.13 Flash Drive (USB Drive)

Flash Memory Cards

Memory cards are used with laptop computers and other electronic devices such as digital cameras, mobile phones and video games. They come in various sizes and with different storage capacity. Flash memory cards are shown in Fig.2.14.

Advantages of using Flash/Chip memory

- It allows fast read/write operations.
- It is non-volatile semiconductor memory.
- It is very light and very small in size.
- It is very reliable.
- Its operation is noiseless since it has no moving part.

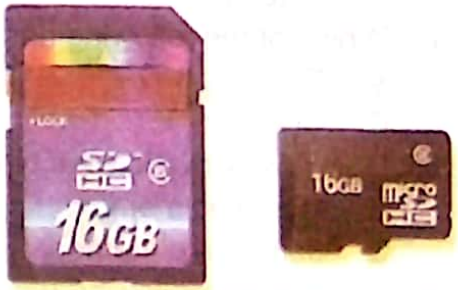


Fig.2.14 Flash Memory Cards

Key Points

- Computer memory is a storage device that holds instructions, data and the results produced after processing by the computer.
- Main memory is high-speed IC chip memory that stores programs and data that the computer is currently executing.

- Cache memory is small amount of high-speed semiconductor memory which exists inside the microprocessor and it is faster than main memory.
- Registers are small memory units inside the processor, used to temporarily store binary information and pass it on to the other parts of the processor or main memory during execution of instructions.
- ROM is Read Only Memory used to store small programs that are frequently required and are not to change during the operation of the computer.
- Secondary memory, also known as backing storage, has huge storage capacity and stores information permanently.
- Optical disk is a plastic-coated disk that can store data in digital form using laser technology as tiny bumps etched on the surface.
- Flash memory is a type of EEPROM. It is solid-state storage device having no moving parts and it is used as hard disk.

Exercise

Q1. Select the best answer for the following MCQs.

i. Which of the following is the fastest memory?
   A. RAM
   B. ROM
   C. Cache memory
   D. USB flash drive

ii. How much is 1MB memory equal to?
   A. 1024 Bytes
   B. 1024 TB
   C. 1024 KB
   D. 1024 GB

iii. Which of the following is volatile memory?
   A. RAM
   B. ROM
   C. PROM
   D. EEPROM

iv. Which of the following has highest storage capacity?
   A. DVD
   B. Blu-ray Disk
   C. CD
   D. Floppy Disk

v. USB flash drive is what type of memory?
   A. Magnetic memory
   B. Optical memory
   C. Solid State memory
   D. Primary memory

vi. Which of the following memory devices has the smallest storage capacity?
   A. RAM
   B. Cache memory
   C. CD
   D. Memory card

vii. Which of the following storage device is obsolete now days?
   A. Hard disk
   B. CD
   C. Memory card
   D. Floppy disk

viii. Which memory communicates directly with the CPU?
   A. Main memory
   B. Secondary memory
   C. Hard disk
   D. USB flash drive

ix. Which of the following memory devices has sequential access to data?

A. Magnetic disk
B. Optical memory
C. Magnetic tape
D. Chip memory

x. Where are the registers located?

A. Inside hard disk
B. Inside DVD
C. Inside RAM
D. Inside Microprocessor

Q2. Write short answers of the following questions.

i. State three differences between primary and secondary memory.
ii. Differentiate between sequential access and direct access memory.
iii. Why data access time in sequential access devices is more than the random access devices?
iv. If cache memory is removed from a computer, what will happen to it?
v. Define memory word.
vi. Differentiate between RAM and ROM.
vii. What is the purpose of secondary memory?
viii. Give few advantages of using flash memory?
ix. How the size of RAM affects the processing speed of a computer system?

Q3. Write long answers of the following questions.

i. What is Internal processor memory? Explain different types of internal processor memories used in computers.
ii. Explain magnetic tape and hard disk.
iii. What is optical disk? Describe its types.
iv. What is Flash or Chip memory? Explain its types.

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. Different types of IC chips (like RAM chip) should be shown to the students. Students should know where these are fixed on the motherboard and their functions should also be explained.
2. Magnetic tape in cassette or reel form should be shown to the students and they should know how information is stored on it.
3. Internal and external hard disk should be shown and their operations should be explained.
4. Students should practically use different types of optical disks in the computer.
5. Working of USB flash drive and various types of memory cards is to be demonstrated to the students.
6. Teacher may ask the students to use the website www.howstuffworks.com for learning purpose.

3

CENTRAL PROCESSING UNIT

After completing this lesson, you will be able to:

- Define CPU and its components (ALU, CU, Register, Cache and Internal Buses)
- Describe the functions of general purpose and special purpose registers
- Define bus and explain data bus, address bus and control bus
- Define instructions and its types
- Explain instruction formats
- Describe instruction cycle (Fetch, Decode and Execute)
- Describe CISC and RISC architecture
- Differentiate between Intel Pentium IV and AMD Athlon processors

Reading

UNIT INTRODUCTION

Central Processing Unit (CPU) is the main part of any computer system. This unit explains central processing unit and the components inside it. It describes instruction formats and their execution by the control unit. It describes how control unit cycles through fetch, decode and execute operations to carry out program instructions stored in main memory. It also discusses the role of registers and buses in programs execution.

3.1 INSIDE CPU

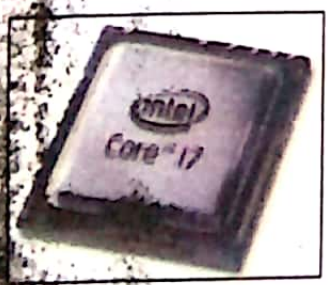


Fig.3.1 Intel Core I7 Microprocessor

Computers have the capabilities to store and process a large amount of information at extremely high speed and produce accurate results. Computers can work for many hours uninterruptedly and can do the same jobs repeatedly that would be impossible without them.

The Central Processing Unit (CPU) is the main part of the computer which performs all its activities. It is also called the processor or microprocessor and is truly the "brain" of the computer

DO YOU KNOW?

The Intel 4004, a 4-bit central processing unit (CPU) was released by Intel Corporation in 1971. It was the first microprocessor.

Teacher Point

Before starting the chapter, the students could be encouraged to explain what they understand about Computer Central Processing Unit (CPU).

system. It combines the circuitry that generates all the control signals needed to execute instructions. A latest CPU or microprocessor is shown in Fig.3.1.

3.1.1 COMPONENTS OF CPU

The following are main components of CPU.

- ALU
- CU
- Registers
- Cache Memory
- Internal Buses

Arithmetic Logic Unit (ALU)

Arithmetic logic unit (ALU) is the part of the CPU where the actual processing takes place. ALU is capable of performing arithmetic, logical and data manipulation operations on data.

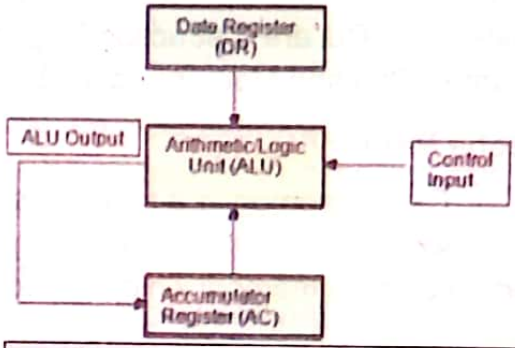


Fig.3.2 Arithmetic Logic Unit

The ALU consists of logic circuitry that performs operations such as addition, subtraction, multiplication, division, exponentials, data manipulations (for example, shifting), comparisons and logical operations such as AND, OR. NOT, etc. on the data contained in the registers. An ALU is shown in Fig.3.2 with its associated registers.

How ALU works?

Suppose we want to add two numbers 30 and 45. The ALU will perform the following steps to do this addition.

1. The first number, 30 will be stored in the Accumulator Register (AC).
2. The second number, 45 will be stored in the Data Register (DR).
3. Control unit (CU) will send the command to add the numbers through the control input.
4. Two numbers, 30 and 45 will be added by the circuitry in the ALU.
5. The result 75 will appear at the ALU output and will be transferred to AC.
6. Finally, the result 75 will be sent to the main memory from AC.

Control Unit (CU)

Control unit directs and coordinates the activities of the entire computer system. It controls the working of all the input/output devices, all the primary and secondary storage devices and the calculations performed by the ALU. Control unit controls the operations of computer system based on the instructions in the program by executing them in a proper order.

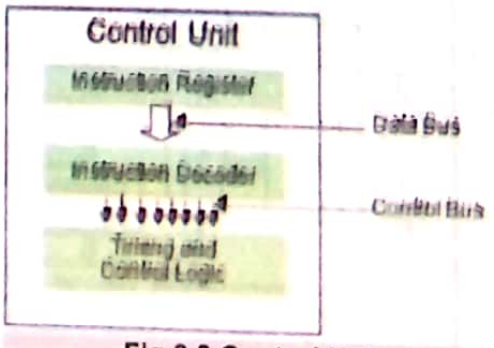


Fig.3.3 Control Unit

Control Unit consists of three main components, Instruction Register, Instruction Decoder and Timing and Control Logic as shown in Fig.3.3. Instruction register stores the instruction while it is being executed. Instruction decoder decodes (translates) it and timing and control logic generates the signals to execute it.

Registers

Registers are small memory devices whose function is to temporarily store data/ information and pass it on to the other parts of the processor or main memory during the processing. CPU contains several registers that are used to store various kinds of information needed by the microprocessor as it performs its functions. Some commonly found registers inside the CPU are Instruction Register (IR), Accumulator (AC), Data Register (DR), Program Counter (PC) and Memory Address Register (MAR).

Cache Memory

Cache memory is a small amount of memory inside as well as outside the microprocessor as shown in Fig.3.4. It is faster than main memory but it is very expensive. It stores some active portion of main memory which is frequently required by the CPU.

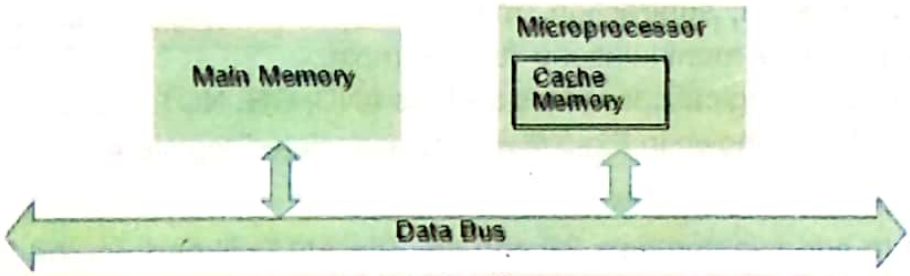


Fig.3.4: Cache Memory

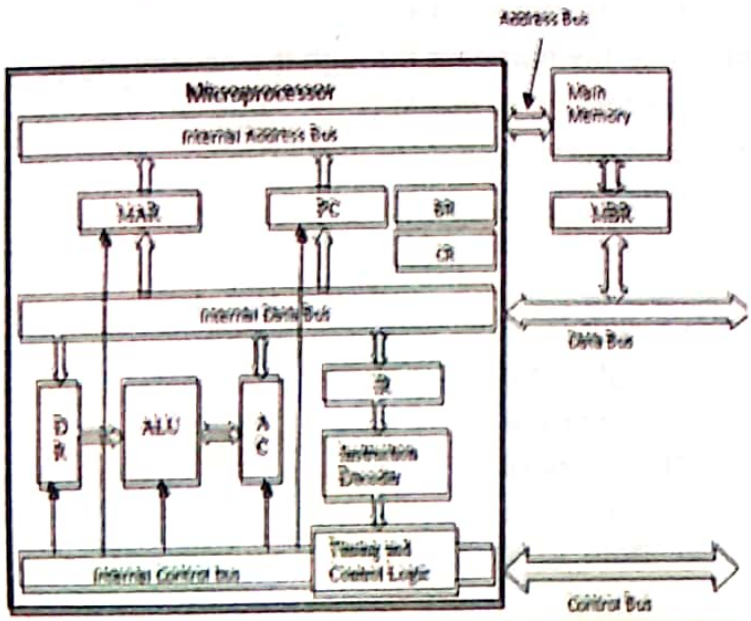


Fig.3.5 Microprocessor bus architecture with associated registers

Internal Buses

A bus is a group of parallel wires used for transmitting data/information from one part of the computer to another. In other words, it provides a path-way for transmitting data/information among various components of a computer. The buses that are found inside the CPU are known as internal buses. There are three types of buses inside the microprocessor which are address bus, data bus and control bus as shown in Fig.3.5.

3.1.2 REGISTERS

Registers are used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU. Registers used in the computer are divided into two types, general purpose registers and special purpose registers. These registers are shown in Fig. 3.5.

General Purpose Registers

General purpose registers are used to store data as well as addresses. These registers are used for arithmetic data movement. Typically these are 8 to 32 bit registers. Following are the commonly used general purpose registers.

- **Accumulator Register (AC) and Data Register (DR)**

These two registers hold the operands (values) that the ALU operates on during the execution of an instruction. Operands are values on which operations such as addition or multiplication is to be performed. Operands are loaded into these registers from memory. After performing the operation, the results of ALU are transferred to the accumulator (AC). Both the accumulator and the data registers can receive data from memory over the data bus but only the accumulator can send data/information back to the memory.

- **Base Register (BR)**

It is used to hold a number that can be added to (or, in some cases, subtracted from) the address portion of a computer instruction to form an effective address. It is also known as Index register.

- **Counter Register (CR)**

It contains the address (location) of the instruction being executed at the current time. As each instruction gets fetched, the counter register increases its stored value by 1. After each instruction is fetched, it points to the next instruction in the sequence. When the computer restarts or is reset, it normally reverts to 0.

Special Purpose Registers

These registers hold the state of a program. They include program counter, instruction register, memory address register and memory buffer registers. These are used by Control Unit to control the operations of CPU and by the Operating System programs to control the execution of the programs. Following are the special purpose registers.

Teacher Point

Teacher should explain difference parts of CPU with the help of diagram.

- **Instruction Register (IR)**

Instruction register holds program instructions that are fetched from the memory for execution. It holds the instruction while the instruction decoder circuit decodes it. After decoding, the timing and control logic generates the proper sequence of control signals to complete the execution of the instruction.

- **Memory Address Register (MAR)**

Memory address register hold the address of memory location from where a memory word is to be fetched or where data is to be stored.

- **Memory Buffer Register (MBR)**

A memory word that is to be stored in or to be fetched from memory must first be transferred into MBR. MBR acts as a buffer (a small temporary memory) allowing the microprocessor and memory unit to act independently without being affected by minor differences in operation.

- **Program Counter (PC)**

It controls the sequence in which instructions are fetched from memory. At any given instant, the contents of PC indicate the address in memory from which the next instruction is to be fetched. Contents of PC are loaded into MAR to fetch an instruction from memory. After fetching an instruction from memory, the PC is incremented by one to point to the next instruction to be fetched.

3.1.3 BUSES

A bus is an electrical pathway inside the computer system over which data/information is transferred from one part to the other. It connects the CPU to the main memory on the motherboard. There are three types of buses, that is, address bus, data bus and control bus as shown in Fig.3.5b.

Address Bus

The address bus is used by the CPU to select a memory word for a read or write operation. It is unidirectional bus because information flows in only one direction. Address bus width is from 16 to 32 bits. A system with a 32-bit address bus can address 2^{32} (4,294,967,296) memory locations.

Data Bus

The data bus is a bidirectional bus over which data can be sent from the microprocessor to memory (Write operation) or from the memory to the microprocessor (Read operation). Although, it is called data bus, the information carried on this will not always be data, it will often be instruction codes fetched by the microprocessor. Data bus width is from 32 to 64 bits.

Control Bus

The control bus is a group of wires that sends timing and control signals to all the parts of computer needed to carry out the instructions. Some of the control lines are outputs from the microprocessor and others are inputs to the microprocessor from I/O devices. Control bus width is in the range of 8 to 16 bits.

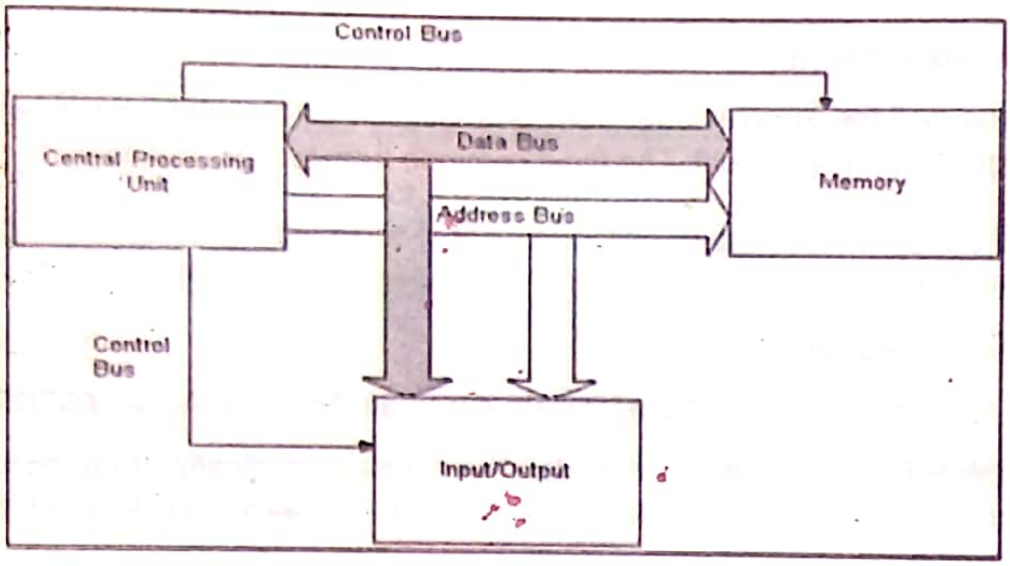


Fig.3.5b System Buses

3.2 CPU OPERATIONS

CPU is the main component of a computer system which carries out the instructions by performing the basic arithmetical, logical, and input/output operations of the system. The fundamental operation of most CPUs is to execute a sequence of stored instructions called a program. The program is represented by a series of instructions that are kept in some kind of computer memory. There are four steps that CPUs use in their operation, these are fetch, decode, execute and store.

3.2.1 INSTRUCTIONS

An instruction (or instruction code) is a group of bits that tells the computer to perform a specific operation. Instructions are stored in the main memory, waiting to be processed by the processor. An instruction has two fields:

- **Operation code**, which represents the action that the processor execute.
- **Operand code**, which defines the parameters of the action. The operand code depends on the operation. It can be data or a memory address.

Operation code	Operand code

Modern computers support many types of instructions. The following are some general types of instructions used in computers.

- Data Transfer Instructions
- Data Processing Instructions
- Program Control Instructions

Data Transfer Instructions

These instructions transfer data from one location in the computer to another location without changing the data content. The most common transfers are between:

- registers and memory,
- registers and I/O,
- registers to registers.

Examples of some common data transfer instructions are MOV, LOAD and STORE.

- **MOV (MOVE)** instruction transfers data from a memory location to a register, register to memory and register to register. This instruction is also used to store the result of a computation.

  Example: MOV A, B (Move the contents of register A to B)

- **LD (LOAD)** instruction loads particular register contents from memory.

  Example: LD A (Load the data to register A from memory)

- **STO (STORE)** instruction stores information from register to memory location.

Data Processing Instructions

These instructions are related to the arithmetic and logic operations. The arithmetic or logic operations are performed on the values of two registers and the result is also placed in a register. Data manipulation instructions can be divided into three basic types, i.e. arithmetic, logical and shift instructions.

Arithmetic Instructions

These instructions are used to perform arithmetic operations. The four basic arithmetic instructions are ADD (Addition), SUB (Subtraction), MUL (Multiplication) and DIV (Division).

Logical Instructions

These instructions are used to perform logical operations like AND, OR, NOT, etc. on binary data stored in registers.

Teacher Point

1. Teacher may also use presentations or animations or videos to explain the working of CPU.

Shift Instructions

Shift instruction is used for transfer of bits either to the left or to the right of an operand.

Program Control Instructions

Program control or transfer of control is a way of altering the order in which statements are executed. There are a number of instructions used for this purpose like JMP (Jump) and LOOP.

- The ***JMP*** instruction jumps to begin the execution at another location.
- The ***LOOP*** instruction is used when number of statements are to be repeated.

3.2.2 INSTRUCTION FORMATS

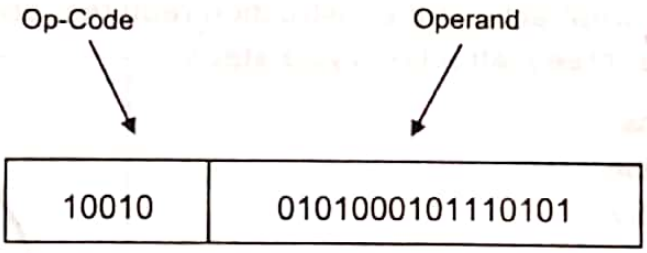
An instruction format defines the layout of the instruction. It consists of two parts, an Op-code (Operation-Code) and Operand.

- Op-Code
- Operand

Op-Code is a group of bits that define various processor operations such as LOAD, STORE, ADD, and SHIFT to be performed on some data stored in registers or memory.

Operand can be data, or can refer to data – i.e. address of data.

Example:



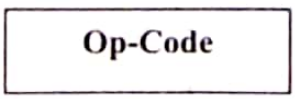
The **Op-code** (10010) specifies the code for **ADD** operation to be performed on the operand at the address specified in **Operand** part.

Some common instruction formats are discussed as follows.

- Zero-Address Instruction
- One-Address Instruction
- Two-Address Instruction

Zero Address Instruction

The Zero Address instruction format requires only op-code, having no operand to work with. Example of the Zero Address instruction format is HALT, STOP, which do not have any address.



Example: STOP

One Address Instruction

One Address instruction format requires one op-code and one Operand. Example of the one address instruction format is LDA (Load Accumulator), JMP (Jump) etc. These instructions require one address to do the operation. Like JMP requires one address in order to jump to that specific address location.

Op-Code	Operand

Example: JMP AX

Two Address Instruction

Two Address instruction format requires one op-code and two operands. Example of such instruction format is the MOV (Move), which moves data from the memory location to the register and from register to the memory location.

Op-Code	Operand	Operand

Example: ADD A, B

3.2.3 INSTRUCTION CYCLE

Instruction cycle is the basic operation cycle of a computer to execute various instructions. It is the process by which a computer retrieves an instruction from its memory, determines what actions the instruction requires, and carries out those actions. The following are the three instruction cycle steps.

- Fetch operations
- Decode operation
- Execute operation

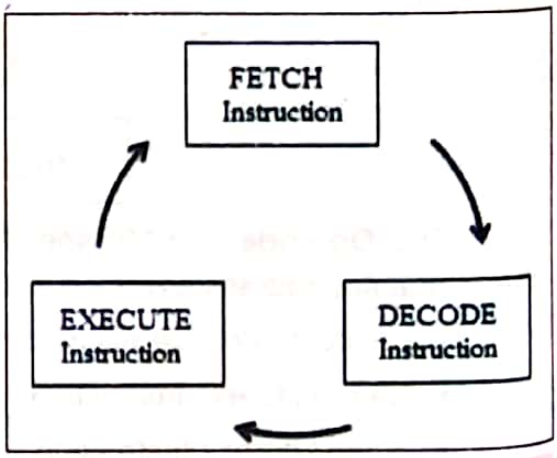


Fig.3.7 Instruction Cycle

- *Fetch Operation*

In this operation the control unit fetches an instruction from main memory by sending an address through the address bus and a read command through the control bus. The fetch operation places the instruction into the instruction register (IR) inside the microprocessor.

- *Decode Operation*

In this step the instruction decoder decodes the instruction to determine what the instruction is intended to do.

Teacher Point

CPU Instruction Cycle should be demonstrated through videos available on net (youtube.com).

- ***Execute Operation***

Once the instruction has been decoded, it can be executed. In this operation the timing and control logic circuitry in the control unit generates signals needed to execute the instruction. The instruction may perform arithmetic, make a decision, simply move data from one memory location to another, etc.

3.2.4 CISC AND RISC ARCHITECTURE

RISC and CISC are two different competing philosophies in designing modern computer architecture.

CISC Architecture

CISC stands for Complex Instruction Set Computer. It is traditional architecture of CPU that supports a large variety of instructions. These instructions may have different length and use all addressing modes and require complex circuitry to decode them. CISC architecture is complex because of the instructions used at the hardware level. Examples of CISC processors are the Intel 486 series and Pentium series.

RISC Architecture

RISC stands for Reduced Instruction Set Computer. It is considered new architecture of CPUs. RISC architecture of CPU supports same size of instructions and it does not use indirect addressing mode. The instructions of a CPU that uses RISC architecture are very simple and are executed very fast. RISC CPUs require fewer transistors, which makes them cheaper to design and easy to manufacture. Examples of RISC processor are IBM PowerPC, Sun SPARC, mobiles phones and tablet PCs.

The following are few differences between CISC and RISC architectures.

- CISC instructions utilize more cycles than RISC.
- CISC has way more complex instructions than RISC.
- CISC typically has fewer instructions than RISC.
- CISC implementations tend to be slower than RISC implementations.
- Computers typically use CISC while tablets, smartphones and other devices use RISC.

3.2.5 INTEL AND AMD PROCESSORS

Intel and AMD (Advanced Micro Devices) are the primary manufacturers of processors. They make processors for desktop computers, laptops, notebooks and mobile devices. Different types of processors perform different functions at different speeds, depending on what kind of system they run. Each type of processor has different functionality, but similarities do exist among various types. Both Intel and AMD make processors for a variety of systems. Core,

Teacher Point

Teacher should give some home assignments to the students at the end of the chapter.

Pentium and Celeron families of processors belong to Intel while Phenom, Athlon and Sem processors belong to AMD.

Intel Pentium IV Processor

Intel Pentium IV processors have 20 steps execution process. They have high c speed and perform fewer operations per clock. Pentium processors generally use 478 sockets and use Mega Hertz (MHz) to specify processor speed.

AMD Athlon Processor

AMD Athlon processors have 10 steps execution process. These processors gener use 462 pin sockets. AMD processors do not use Mega Hertz (MHz) to specify processor spe This is due to the instruction set handling that AMD uses.

The following is the comparison between Pentium IV and AMD Athlon processors.

	Intel Pentium IV Processor	AMD Athlon Processor
Clock Speed	1.7 to 3.0 GHz.	1.4 to 2.33 GHz.
Bus width	32/64 bits	32/64 bits
Cache	256 KB to 1 MB	256/512 KB
Architecture	CISC/RISC	RISC

Key Points

- Central Processing Unit (CPU) is a single unit that consists of ALU and Control Unit. the "brain" of a computer.
- Arithmetic Logic Unit (ALU) is the part of the computer where actual processing takes pla
- Control Unit directs and coordinates the activities of the entire computer system. It contr the working of all the input/output devices, storage devices and the calculations perform by the ALU.
- A bus is a group of parallel wires used for transmitting binary information from one par computer to another. There are three types of buses, address bus, data bus and con bus.
- The general types of instructions used in computers are data movement, operation, sh comparison, branch and input/output instructions.

Instruction code is a group of bits that tells the computer to perform a specific operation.

Control Unit repeatedly cycles through the FETCH, DECODE and EXECUTE steps till the last instruction of the program is executed.

CISC stands for Complex Instruction Set Computer that supports a large variety of instructions which may be as many as three hundred.

RISC stands for Reduced Instruction Set Computer that supports very simple limited number of instruction.

Exercise

1. Select the best answer for the following MCQs.

i. Which part of computer performs Fetch, Decode and Execute cycle?

A. ALU
B. Control Unit
C. Output Unit
D. Registers

ii. Where are the results of ALU operations transferred?

A. Counter register
B. Base register
C. Data register
D. Accumulator register

iii. Which of these buses selects a memory word for a read or write operation?

A. Data bus
B. Control bus
C. Address bus
D. System bus

iv. Which of these registers controls the sequence in which instructions are fetched from memory for execution?

A. Program counter
B. Memory buffer register
C. Data register
D. Counter register

v. A memory word that is to be stored in or fetched from memory must first be transferred into which register?

A. Accumulator
B. Data register
C. Memory buffer register
D. Program counter

vi. Which instruction causes transfer of instruction execution to a specified address?

A. Comparison instruction
B. Branch instruction
C. Shift instruction
D. Data movement instruction

vii. Which of these instructions will perform addition of two numbers?

A. Operation instruction
B. Shift instruction
C. Comparison instruction
D. Data movement instruction

viii. Through which bus, instructions are transferred from main memory to instruction register

A. Control bus
B. Address bus
C. Instruction bus
D. Data bus

ix. How many distinct operations can be performed if op-code of a microprocessor consist of 4 bits?

A. 4
B. 8
C. 16
D. 32

x. Which part of computer decodes instructions?

A. ALU
B. Main memory
C. Program counter
D. Control unit

Q2. Write short answers of the following questions.

i. What is a microprocessor?
ii. What is the function of ALU in the computer?
iii. What is the function of control unit in the computer?
iv. Define bus.
v. Define register.
vi. Define cache memory.
vii. What is meant by instruction code?
viii. What is operation code?
ix. What is the advantage of using address mode in an instruction?
x. Differentiate between CISC and RISC architecture.

Q3. Write long answers of the following questions.

i. Describe general purpose and special purpose registers.

ii. Explain the types of buses used in computers.

iii. Describe the types of CPU instructions.

iv. Explain different types of instruction formats with examples.

v. Explain CPU instruction cycle.

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. Components on the motherboard including microprocessor, RAM and ROM should be shown to the students.
2. Installation of microprocessor on the motherboard along with the cooling fan should be demonstrated.
3. Students should be explained how data bus, control bus and address bus circuits are designed on the motherboard and they should have a clear understanding about their functions.
4. Students should be explained how programs are loaded into the RAM memory and executed by the microprocessor.
5. All the above activities should also be demonstrated through videos or animations.
6. Micro Processor Instruction Cycle should be demonstrated through videos available on net (youtube.com)
7. "How does an ALU work?" Teachers should demonstrate through videos available on net (youtube.com)

4

INSIDE SYSTEM UNIT

After completing this lesson, you will be able to:

- Differentiate between CPU and system unit
- Identify computer casing and its types
- Define power supply and describe the components found on motherboard (BIOS, ports, expansion slots, type of cables, memory slot, disk controller, cooling system and buses)
- Describe the ports (serial, parallel, PS/2, USB and fire wire ports)
- Identify sound, video, modem and network cards
- Describe SIMM, DIMM, SDRAM and DDR

Reading

UNIT INTRODUCTION

This unit presents information about the components of computer that exist inside the system unit. It describes the purpose of expansion cards that are installed on expansion slots on the motherboard or integrated on it. It also explains memory chips, cables used inside the system unit and ports that are found at the back of the system unit for connecting input/output devices.

4.1 COMPUTER CASING AND SYSTEM UNIT

Computer casing is a box or an enclosure that contains most of the components of a computer system. It protects and organizes all the components that make up a computer. Without casing, each of the components within the computer would be vulnerable to dirt, foreign objects and electrical interference. Casing also reduces the overall noise produced by computer fan and drives.

Teacher Point

Before starting the chapter, the students could be encouraged to explain what they understand about the System Unit.

4.1.1 CPU AND SYSTEM UNIT

Computer casing with all the components installed inside it is called system unit or main unit of the computer system. Usually people incorrectly use the word CPU for system unit. Microprocessor is the CPU of the computer that is installed on the motherboard whereas system unit contains motherboard, hard disk, DVD writer, RAM etc. System unit and microprocessor are shown in Fig.4.1.

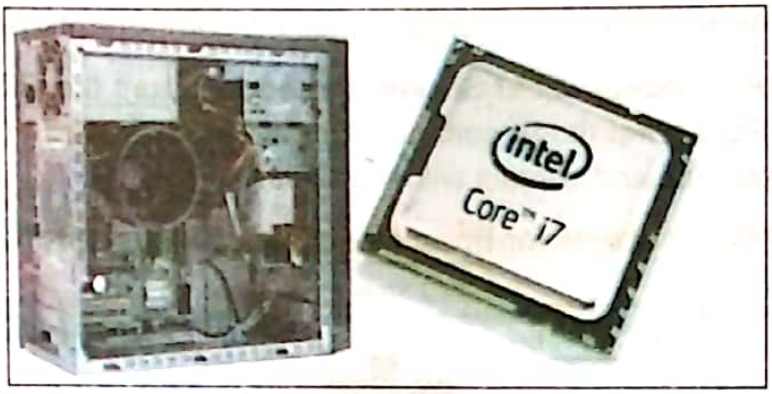


Fig.4.1 System Unit (left) and Microprocessor (right)

4.1.2 COMPUTER CASINGS

Computer casing is a box or enclosure that contains most of the components of computer system. Computer casings are of two types, tower and desktop as shown in Fig.4.2. Tower casing is the most commonly used one. Desktop casing is designed to keep on the desk and usually monitor is kept over it.

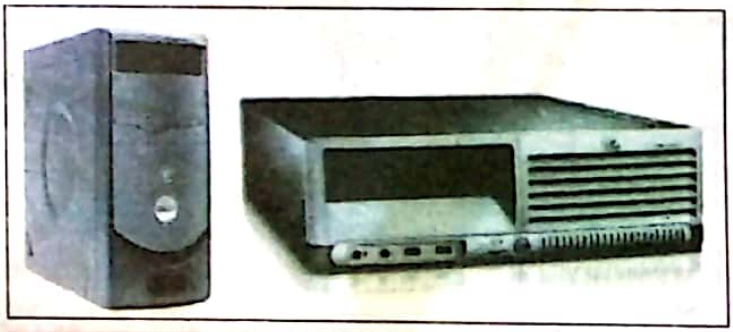


Fig. 4.2 Tower (left) and Desktop (right) computer casings

4.1.3 EXPLORING THE SYSTEM UNIT

System unit contains the following main components.

- Casing
- Power supply
- Motherboard

Power Supply

The purpose of power supply in a computer is to convert alternating current (AC) to low-voltage direct current (DC) for operation of components of the computer. A power supply is already fixed in the casing when it is purchased. A power supply is shown if Fig.4.3

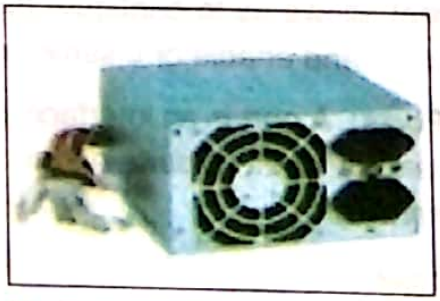


Fig.4.3 Power Supply

Motherboard

Motherboard is also known as main board or system board. A motherboard is shown in Fig.4.4. It is a circuit board that connects all the components of the computer system through ports, cables or expansion slots.

Some Important Components/Parts of Motherboard

The following are some important components or parts of a motherboard.

CPU Socket: CPU Socket is used to mount the CPU or Processor on the motherboard. The CPU socket is the connector on the motherboard that houses a CPU and forms the electrical interface and contact with the CPU.

BIOS: It stands for Basic Input Output System. It is a non-volatile ROM chip. It is a firmware in

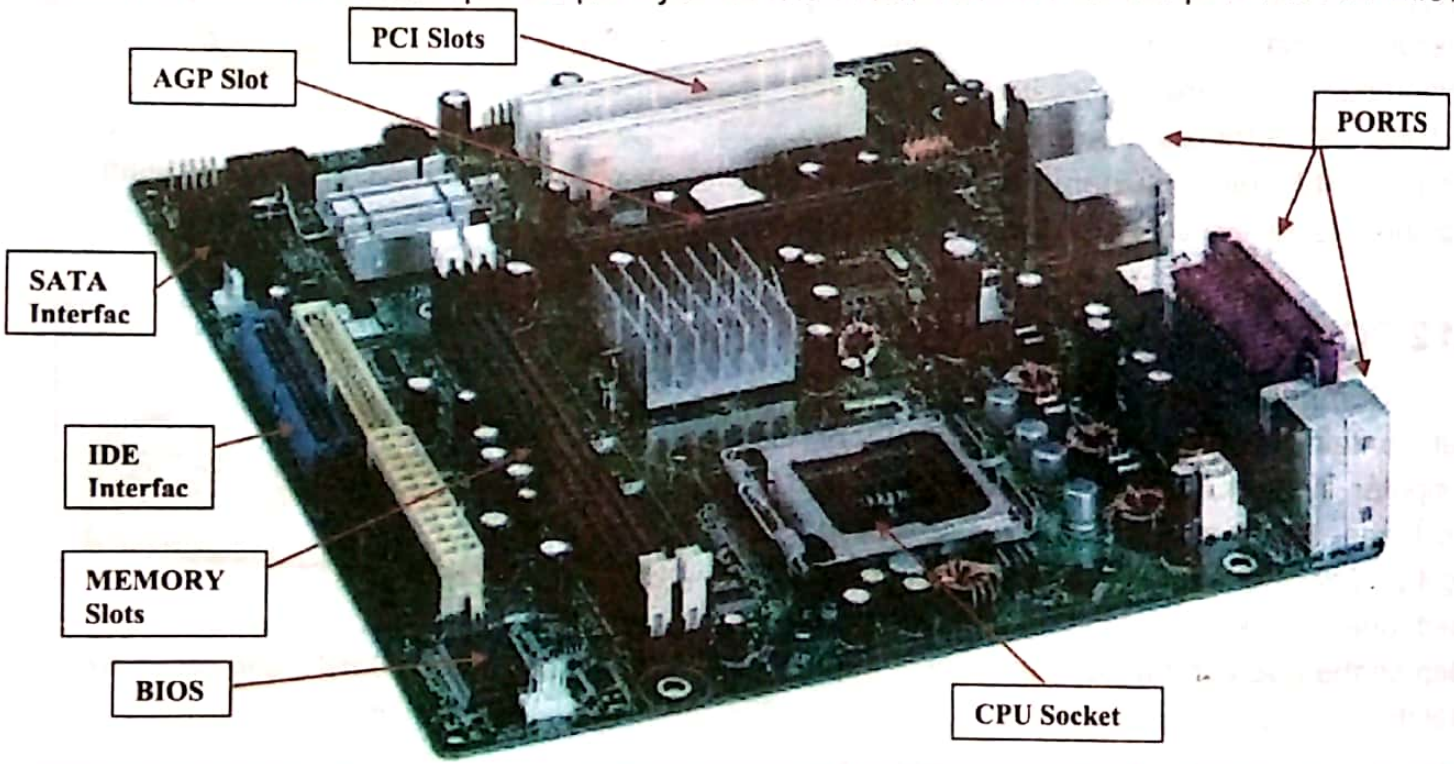


Fig.4.4 Motherboard

which system programs are permanently stored by the manufacturer. These programs have two purposes. When the computer is turned on, it initializes the computer devices such as keyboard, mouse, Hard disk, etc., and then loads the operating system from the hard disk into the RAM and makes the computer ready for operation. Secondly, it controls the basic input/output operations of all the peripheral devices attached to the computer. BIOS also has a Setup utility that allows us to configure the computer hardware, select boot device, set password, set the clock and enable or disable computer components.

Ports: A port is an interface at the back of the computer to connect external devices. There are various types of ports on the motherboard which are used for connecting input/output devices via cable.

Expansion Slots: An expansion slot is a long narrow socket on the motherboard on which circuit boards (expansion cards) are inserted to add new capabilities to the computer. There are

Teacher Point

Teacher should explain the difference between System unit and the CPU.

different types of expansion slots on the motherboard in which various types of cards are fixed. These include video display, sound, modem and network cards. In modern computers, the circuitry of many of these cards is integrated in the motherboard itself to reduce size and cost. Expansion slot standards include, AGP, PCI and PCI express. Expansion slots are shown in Fig.4.5.

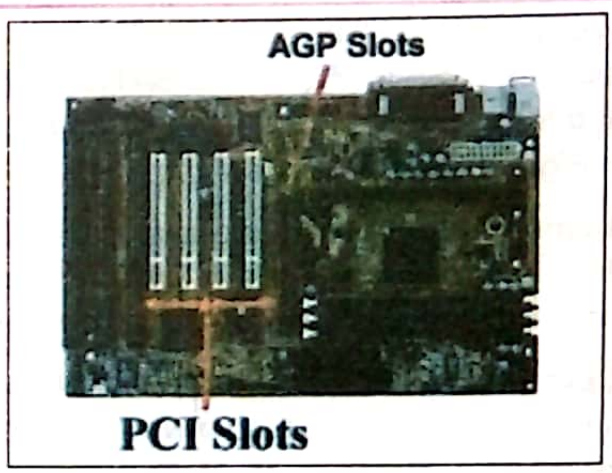


Fig.4.5 Expansion slots on motherboard

AGP: It stands for Accelerated Graphics Port. It provides a high-speed channel for attaching video card to a motherboard. It provided a dedicated path-way between the processor and the graphics card. Its bus width is 32 bits.

PCI: It is used to attach different expansion cards to the computer. It is still used in some computers but is superseded by PCI Express. PCI Express was designed to replace PCI and AGP standards. PCI Express has a bus width of 32 bits. It is the latest standard expansion slot used in micro and laptop computers. The main advantage of PCI Express is that it provides high speed serial communication.

***Ribbon Cable*:** It has several parallel wires in the same flat plane that looks like a piece of ribbon which is why it is called ribbon cable. It was used in the past for transmitting information between motherboard and devices such as floppy drive, hard disk and CD-ROM drive.

Following are the different three types of ribbon cable interfaces.

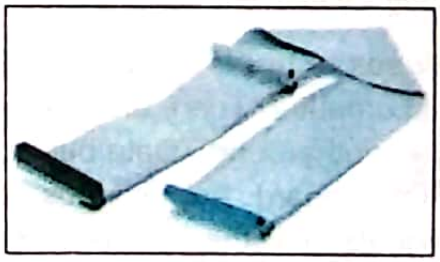


Fig.4.6 IDE Interface Cable

IDE Interface and Cable: Integrated Drive Electronics (IDE) interface was developed by Western Digital for attaching hard drives to motherboard. The first hard drive that used IDE interface appeared in Compaq PCs in 1986.Hard drives that had IDE interface had drive controller integrated into the drive itself rather than having a separate controller on the motherboard. Western Digital introduced new hard drives in 1994 with enhancements to IDE interface and named it Enhanced IDE (EIDE). An IDE interface cable is shown in Fig.4.6.

SATA Interface and Cable: Serial Advanced Technology Attachment (SATA) is a new computer interface bus for connecting drives to computer. It was designed to replace EIDE bus interface. SATA bus interface is used in all the modern laptop and desktop computers. SATA drives communicate via high-speed serial cable. SATA bus interface has many advantages

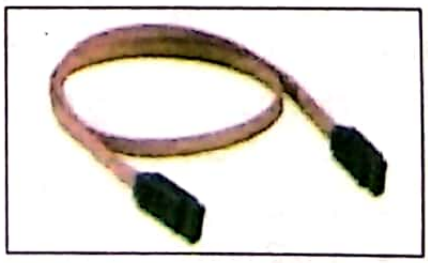


Fig.4.7 SATA Interface Cable

Teacher Point

Teacher should explain difference parts of Motherboard with the help of diagram.

over the older EIDE standard. These include faster and more efficient data transfer rate and reduced cable size and cost. SATA 1, SATA 2 and SATA 3 interfaces provide communications at rates of 1.5 GB/Sec, 3 GB/Sec and 6 GB/Sec respectively. A SATA interface cable is shown in Fig.4.7.

Memory Slots: These are slots on the motherboard that connect RAM with the CPU. Generally, there are two memory slots. RAM cards are inserted in these slots. RAM card is a printed circuit board having a series of RAM chips mounted on it.

Disk Controller: It is a circuit that allows communication between CPU and any type of drive such as floppy drive, hard drive or CD-ROM drive. Old disk controllers were implemented on a separate controller card. Modern disk controllers are integrated into the disk drive itself. For example, EIDE and SATA hard drives have their disk controller circuit inside the drives.

Fig.4.9 Fan for Cooling Microprocessor

Cooling System: Cooling system is required to maintain proper operating temperature inside the system unit. Computer components installed inside the system unit produce heat when the computer is on. If the temperature inside the system unit reaches a certain point, it can damage the parts. A fan is fixed on top of the microprocessor to cool it down. Heat sinks are also used to dissipate the surface area. Many computers are designed to turn themselves off if the temperature exceeds certain level. A fan for cooling microprocessor is shown in Fig.4.9.

Buses: A bus is a set of parallel wires that provides electrical path between various components of computer. There are three types of buses, data bus, address bus and control bus, printed on the motherboard. Data bus connects the CPU, memory and the other hardware devices on the motherboard. Address bus connects the CPU and RAM. Control bus is used to send control signals to all the components of the computer.

4.2 PORTS, EXPANSION CARDS AND MEMORY CHIPS

4.2.1 PORTS AND THEIR TYPES

Various types of ports exist on the motherboard and they protrude at the back of the system unit for connecting devices.

The following are different types of ports

- Serial port
- Parallel port
- PS/2 port
- USB port
- Fire wire port
- HDMI port

Serial Port

Serial ports transmit one bit of data at a time. In old computers, serial ports had 9 or 25 pins in which one pin was used for transmitting data and the rest transmitted signals and these were called COM1, COM2 and COM3. Generally modems were connected to these ports. These ports have been replaced with USB ports. A serial port is shown in Fig.4.10.

Fig.4.10 Serial Port

Parallel Port

Parallel ports can transmit multiple bits over several wires at a time. These ports had 25 pins in which 8 pins transmitted one byte of information and the others were used for transmitting control signals. Parallel ports were named as LPT1, LPT2 and LPT3. These ports have been replaced with USB ports. A parallel port is shown in Fig.4.11.

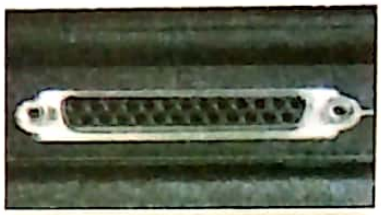


Fig.4.11 Parallel Port

PS/2 Port

PS/2 stands for IBM's Personal System 2 microcomputer. PS/2 system introduced a new type of port for connecting keyboard and mouse which are still used in many computers. It is a round shaped serial port. A PS/2 Port is shown in Fig.4.12.

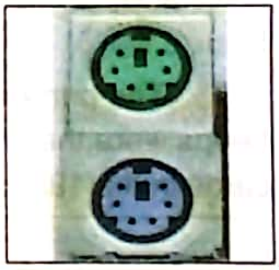


Fig.4.12 PS/2 Port

USB Port

USB stands for Universal Serial Bus. It provides very fast serial transmission. It is the most commonly used port in modern computers for connecting a large variety of devices to the computer such as printers, scanners, cameras, mouse, keyboard and USB flash drives. A computer has many USB ports and these are plug-and-play ports. Plug-and-play ports automatically detect and determine what type of device is attached to the computer. When a computer detects a plug-and-play device it automatically installs the driver for it or prompts the user to install it. A USB port is shown in Fig.4.13.

Fig.4.13 USB Port

Fire Wire Port

It is a rectangular shaped port, generally used for connecting video devices such as camcorder to the computer. Fire wire port has four or six pins. In a six pin connection, 2 extra pins are used to provide electric power. Laptop computers have 4.pin fire wire port because they do not provide electric power to devices connected to it. A fire wire port is shown in Fig.4.14.

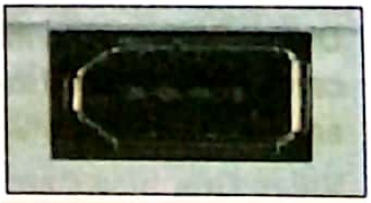


Fig.4.14 Fire Wire Port

Fig.4.15 HDMI Port

HDMI Port

HDMI stands for High Definition Multimedia Interface. HDMI technology provides audio-video interface for transmitting digital data. All the high definition equipment including PCs, laptops, camcorders, digital cameras, TV, DVR, disk players and set-top box sold today have at least one HDMI port. HDMI port transmits high quality audio-video data in totally digital form through a single cable. HDMI port is shown in Fig.4.15.

4.2.2 TYPES OF EXPANSION CARDS

Expansion card is a printed circuit board that is inserted onto an expansion slot on the motherboard. It is also known as add-on card, interface card or just card. It gives new ability to computer such as connecting to another computer using a network cable.

Four types of expansion cards are commonly used in computers. These are sound card, video graphics card, modem card and network interface card.

Sound Card

The purpose of sound card is to facilitate transmission of sound in computer. In the past, beeps were the only sound that could be produced on the computer. With the invention of sound cards in the 1980s, we can store human voice in the computer and hear it through the speakers.

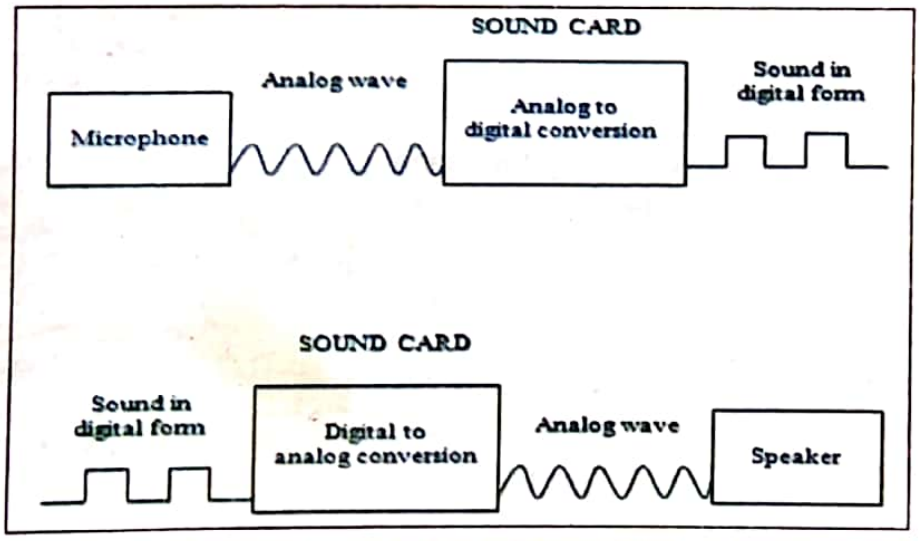


Fig. 4.16 Working of Sound Card

Sounds are analog waves whereas computers communicate using electrical pulses that represent 0s and 1s. Sound card translates analog voice input form a microphone into digital form or it outputs the digital sound stored in the computer through the speakers. In other words, it provides analog to digital and digital to analog conversion as shown in Fig.4.16.

It will not be possible to play DVDs, CDs and run multimedia applications on a computer without the sound card. Early sound cards were installed in expansion slots on the motherboard. Motherboards of modern computers are manufactured with integrated sound cards.

Video Graphics Card

The purpose of a video graphics card is to display text, graphics and images on the screen. In the past, video cards were installed in expansion slots but in modern computers, video hardware is integrated on the motherboard. Video hardware that is integrated on the motherboard is known as integrated graphics or on-board graphics. Integrated graphics uses some of the computer's RAM and reduces the total RAM capacity. These motherboards have

an AGP, PCI or PCI Express slot for adding a high performance graphics card in place of the integrated graphics. These high performance 3D graphics cards have their own dedicated memory which is generally between 256MB to 1GB. Special high performance 3D graphics cards are required for running some video games. A video graphics card is shown in Fig.4.17

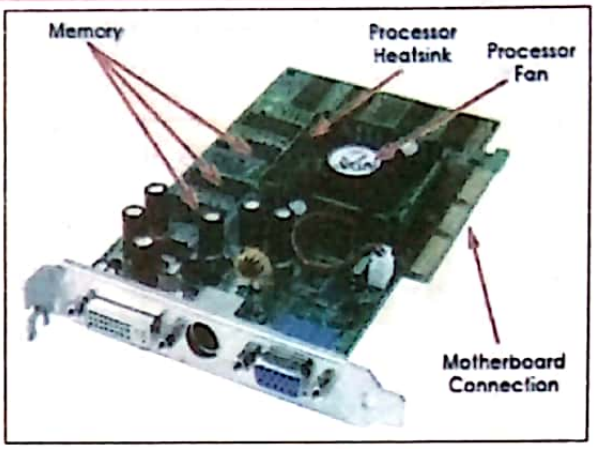


Fig. 4.17 Video Graphics Card

Modem Card

A modem is a communication device that makes possible the transmission of data between computers via telephone line or other communication lines. It is abbreviation of MOdulator-DEModulator. Modems are generally used for dial-up connection to Internet. Modem cards are fixed in expansion slot or modem hardware is integrated on the motherboard.

There are three types of modems.

- Dial-up modem
- ISDN modem
- DSL modem

Dial-up modems use telephone lines and they can provide transmission speed up to 56 Kbps (Kilobits per second) which is very slow. Therefore, there use is gradually declining. It has the advantage of providing Internet connection from any location in the world and it is the cheapest Internet connection.

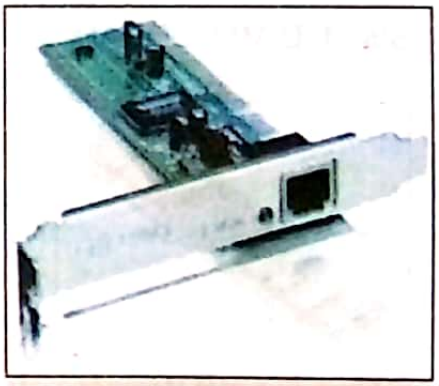


Fig.4.18 10/100 Ethernet Card

ISDN modem is used with Integrated Services Digital Network. Here, "Integrated" means combining of voice and data services over the same wire. It uses the same phone lines that dial-up modems use. It can provide Internet connection speed up to 128 Kbps.

DSL (Digital Subscriber Line) modem is used with DSL connection to the Internet. These modems are more advanced compared to dial-up and ISDN modems. They provide extremely fast Internet speed depending upon the package and services of Internet Service Provider (ISP). Dial-up and ISDN modems are gradually replaced by DSL modems for high-speed Internet connection using digital subscriber line. It also uses phone lines. DSL Internet connection is more expensive than dial-up and ISDN connections.

Network Interface Card

Network Interface Card (NIC), commonly known as network card or LAN card, is an expansion card that provides interface to a network. Modern computers have network interface integrated into the motherboard, just like the sound and graphics cards. Network card allows computer users to connect to each other either by using cables or wirelessly. It provides

communication between computers in LAN and WAN. Following are the types of commonly use network cards.

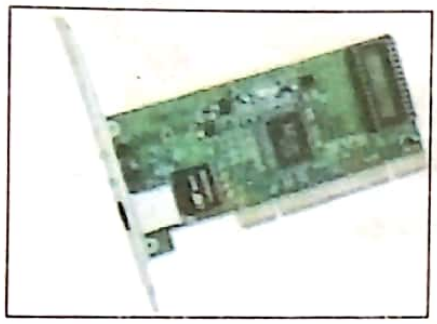


Fig.4.18 Gigabit Card

10/100 Ethernet cards are used in home and small offices. Their data transfer rate is 10 to 100 Mbps (Mega bits per second). They are usually attached to PCI or PCIe slots. A 10/100 Ethernet card is shown in Fig.4.18

Gigabit card

Gigabit cards have data transfer rate of up to one Gbps (Giga bits per second). These cards are attached to computers using PCIe slot. A Gigabit card is shown in Fig.4.18.

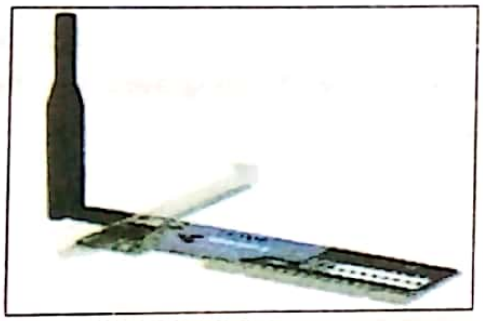


Fig.4.19 Wireless Network Card

Wireless network card

Wireless network cards are used for wireless networking. Their data transmission speed is generally less than wired cards. They are attached to PCIe slot or USB port. A wireless network card is shown in Fig.4.19

4.2.3 MEMORY CHIPS

Memory chips can be classified into four categories, SIMM, DIMM, SDRAM and DDR SDRAM.

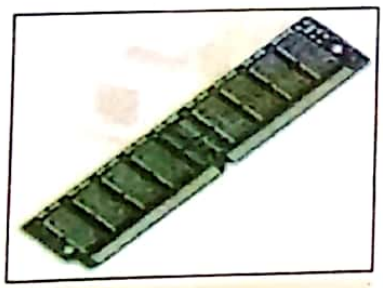


Fig.4.20 SIMM Memory

SIMM

SIMM stands for "Single In-line Memory Module". It is a small circuit board with a bunch of memory chips on it as shown in Fig.4.20. SIMM is plugged-in into particular socket on the motherboard. It is used to add memory to computer and is referred as Random Access Memory. SIMMs typically use up to 32.bit bus. They have storage capacity ranging from 256KB up to about 32MB. SIMMs were used in early computers of 80s and 90s.

DIMM

DIMM stands for "Dual In-line Memory Module". It is a type of computer memory. A DIMM is a small circuit board that holds memory chip. It uses a 64.bit bus to the memory, whereas single in-line memory module (SIMM) only has a 32.bit path. This allows DIMMs to transfer more data at once. DIMMs have replaced SIMMs because they have faster data transfer rates and better capabilities than DIMMs. Memory capacities of DIMMs range from 64MB up to 512MB.

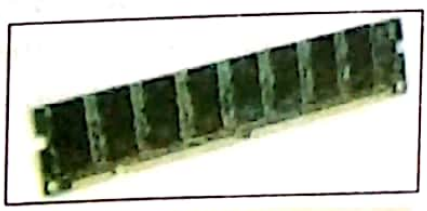


Fig.4.21 DIMM Memory

Teacher Point

Teacher should give some home assignments to the students at the end of the chapter.

SDRAM

SDRAM stands for "Synchronous Dynamic Random Access Memory". SDRAM is an improvement to standard DRAM because it retrieves data alternatively between two sets of memory. This eliminates the delay caused when one bank of memory addresses is shut down while another is prepared for reading. It is called "Synchronous" DRAM because the memory is synchronized with the clock speed that the computer's CPU bus speed is optimized for. The faster is the bus speed, the faster will be the SDRAM.

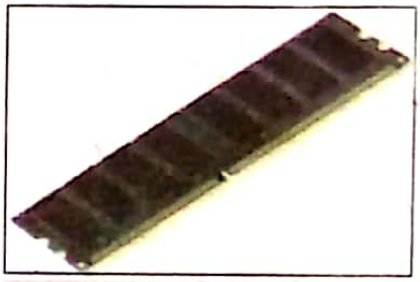


Fig.4.22 SD RAM

DDR SDRAM

DDR SDRAM (Double Data Rate SDRAM) is synchronous dynamic RAM that has improved memory clock speed as compared to simple SDRAM. It reads or writes two consecutive words per clock cycle. New type of SDRAMs, known as DDR 2 and DDR 3 have also come which are used in latest microcomputers. DDR 2 reads or writes 4 words of data per clock cycle whereas DDR3 reads or writes 8 data words per clock cycle.

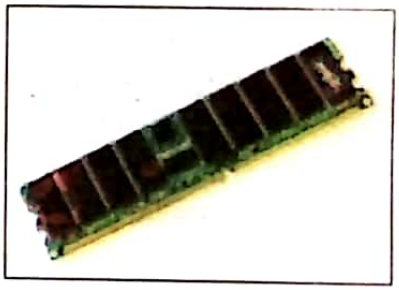


Fig.4.23 DDR SDRAM

Key Points

Computer casing is a box that contains most of the components of a computer.

Computer casing with all the components installed inside it is called system unit or main unit of computer.

Power supply is used in computer to convert alternating current (AC) to low-voltage direct current (DC) for operation of components of the computer.

Motherboard or main board is a circuit board that connects all the components of computer system through ports, cables or expansion slots.

Disk Controller is a circuit on the motherboard that allows communication between CPU and any type of drive such as hard drive or CD drive.

Computers have various types of ports on the motherboard that protrude at the back of the system unit for connecting devices.

Serial ports transmit one bit of data at a time over a single wire whereas parallel ports transfer multiple bits over several wires at the same time.

Expansion card is a printed circuit board that is inserted onto an expansion slot on the motherboard. It is also known as add-on card, interface card or just card. Commonly used expansion cards are sound card, modem card, network interface card and graphics card. In modern computers these card are integrated on the motherboard.

SIMM stands for Single In-line Memory Module. It is a small circuit board on which RAM chips are wired together.

DIMM stands for Dual In-line Memory Module. It is also a small circuit board like SIMM but it provides wider data bus and has more storage capacity.

Exercise

Q1. Select the best answer for the following MCQs.

i. Which port is generally used to connect video devices to the computer?
   A. Fire wire port
   B. USB port
   C. PS/2 port
   D. Parallel port

ii. What is computer casing with all the components installed inside it called?
   A. Computer System
   B. CPU
   C. Motherboard
   D. System unit

iii. What is the interface that provides connection to external devices called?
   A. Expansion slot
   B. Memory slot
   C. Disk controller
   D. Port

iv. Which of the following provides interface to network?
   A. NIC
   B. Modem
   C. Parallel port
   D. BIOS

v. Which part of computer protects and organizes all the main parts of a computer?
   A. Power supply
   B. Motherboard
   C. Casing
   D. Expansion slots

vi. What is the purpose of power supply in the computer?
   A. to convert low-voltage to high-voltage
   B. to convert DC to AC
   C. to convert AC to low-voltage DC
   D. to generate power

vii. Which circuit board connects all the components of computer?
   A. Motherboard
   B. Ports
   C. Network card
   D. Cables

viii. What is BIOS?
   A. Programs in RAM
   B. Port
   C. Interface
   D. Non-volatile ROM chip

ix. Which of these provides high-speed channel for attaching video card to motherboard?
   A. IDE interface
   B. AGP
   C. Disk controller
   D. Memory slot

x. Which card displays text, graphics and images on the screen?
   A. Network card
   B. Gigabit card
   C. Modem card
   D. Video graphics card

Q2. Write short answers of the following questions.

i. Define computer casing and describe its types.
ii. Differentiate between computer casing and system unit.
iii. What is the function of power supply in the computer?
iv. Define motherboard.
v. What is the function of BIOS in the computer?

vi. What is the function of disk controller in the computer?
vii. Define port and expansion slot.
viii. Write a brief note on cooling system used in the computer.
ix. Differentiate between SIMM and DIMM.
x. Give one advantage and two disadvantages of using wireless network card.

Q3. Write long answers of the following questions.

i. Explain IDE and SATA interfaces.
ii. Describe the following types of ports.
- Serial port
- Parallel port
- PS/2 port
- USB port
- Fire wire port

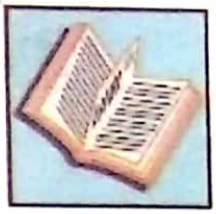
iii. What are the functions of following expansion cards?
- Sound card
- Video display card
- Modem card
- Network Interface Card (NIC)

iv. Explain different types of modems.
v. Describe commonly used Network Interface Cards (NICs).

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. Students should be shown the components found inside the system unit such as CPU Socket, BIOS, ports, expansion slots/cards, types of cable interfaces and cables used, memory slots and microprocessor and their functions should be explained.
2. Fixing of all the components inside the computer casing (on the motherboard) should be demonstrated so that the students understand how system unit is assembled.
3. The mounting and dismounting of CPU should be demonstrated to the students.
4. All the above activities should also be demonstrated through videos or animations.



5

NETWORK COMMUNICATION AND PROTOCOLS

After completing this lesson, you will be able to:

- Define basic network components (Sender, Receiver and Medium)
- Describe modes of communication (simples, half-duplex and full-duplex)
- Describe communication media (Guided and Un-guided)
- Identify communication devices (Switch, Router and Gateway)
- Understand network architecture (Client/Server and Peer-to-Peer)
- Identify network types (LAN, MAN, WAN and VPN)
- Identify network topologies (Star, Ring, Bus and Mesh)
- Identify the purpose of a communication standards
- Understand OSI Model and concepts of its layers
- Provide examples of protocols and devices at each layer of OSI Model
- Describe TCP/IP protocol suite used for communication over the Internet
- Compare the TCP suite with OSI Model
- Differentiate between circuit switching and packet switching
- Understand IP addressing schemes (Classes, Masks and Subnets)

Reading

UNIT INTRODUCTION

A network is a collection of computers or other devices called nodes that communicate with each other on a shared network medium. This unit is dedicated to data communication over computer networks and the protocols that make it possible. It describes how computer networks are created and what their advantages are. It introduces different types of computer networks and network devices. It describes the purpose of having communication standards and discusses OSI model that allows computers of different manufacturers to communicate with each other. The last section of this unit explains how IP addressing schemes identify a computer on Internet.

Teacher Point

- Before starting the chapter, the students could be encouraged to explain what they understand about the Computer Networks.

5.1 NETWORK COMMUNICATION

People use computer networks almost daily to conduct personal and professional business. This trend is accelerating as more people discover the power of computers and communication networks both for businesses and for homes. The day-to-day transactions at departmental stores, banks, reservation counters and other businesses are all dependent upon computer networks.

A computer network is an interconnection between two or more computers and/or other network devices so that they can communicate with each other to share network resources (both hardware and software). A network is made up of collection of computers and other network devices that allow information exchange to take place. While most networks connect computers using some form of cable, the connections can also be wireless, for example radio or microwave communication. A simple communication network having wired and wireless connections is shown in Fig.5.1.

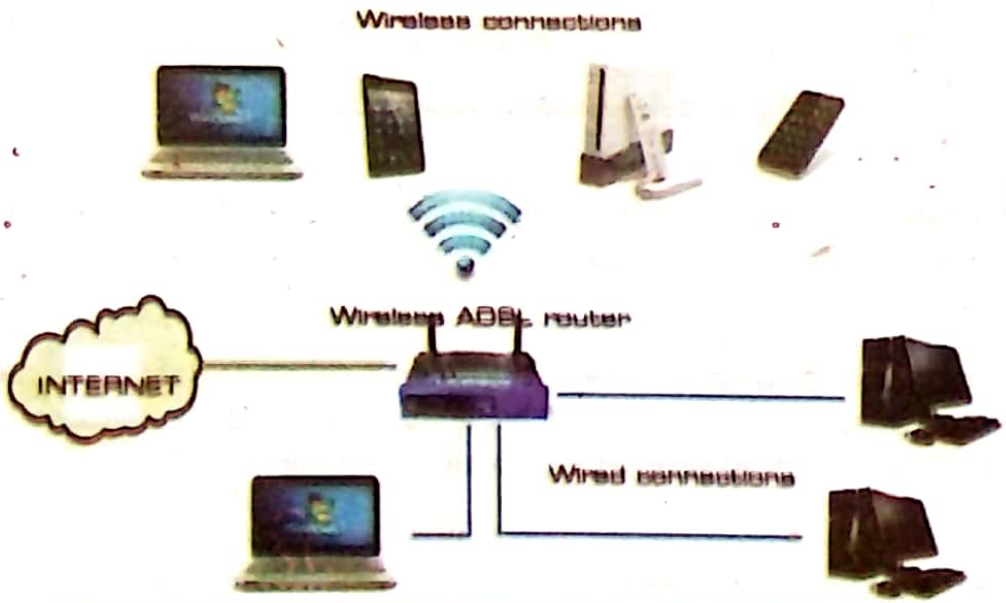


Fig.5.1 A Communication Network

5.1.1 BASIC NETWORK COMMUNICATION COMPONENTS

Data communication is the process of transferring information from one point to another in a networking environment. Network communication consists of five basic components, as shown is Fig.5.2.

- Sender
- Message
- Medium
- Protocol
- Receiver

Sender

Sender, also called transmitter is a computer/device that sends the message (data or information) from source to destination in a communication network. It may be a computer, workstation, cell phone or camera. The sender device converts the electrical signal into a form that is suitable for transmission over the communication network.

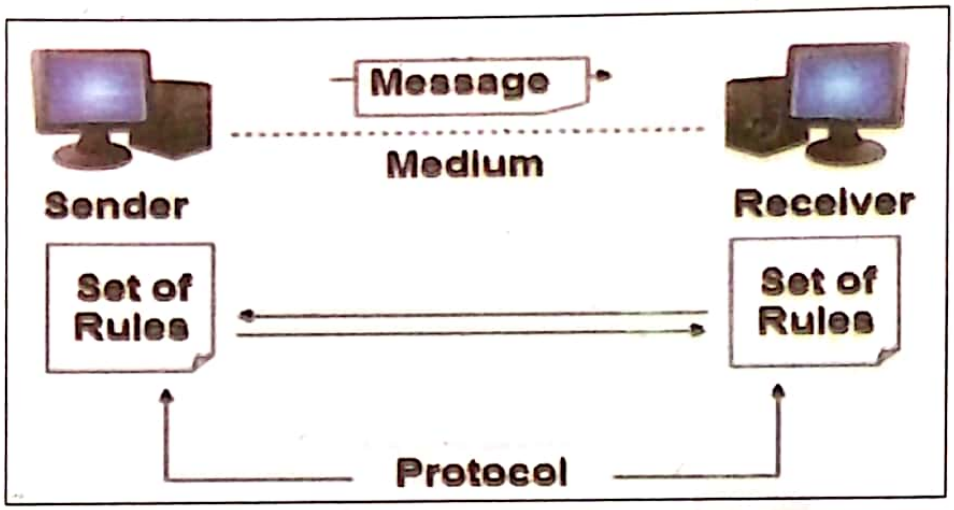


Fig.5.2 Components of Network Communication

Message

Message is the data or information that is to be transmitted. Message can be in the form of text, audio, video, or any combination of these.

Medium

Medium is the path through which message travels from source to destination. Medium can be wired, for example telephone cable, coaxial cable and fibre optics. It can also be wireless for example Bluetooth, Wi-Fi, microwave, radio wave and satellite.

Receiver

Receiver is the device which receives transmitted message. It can be a computer, workstation, telephone handset or television set. The data received from the transmission medium may not be in proper form to be accepted to the receiver and it must be converted to appropriate form before it is received.

Protocol

A protocol is a set of rules that governs data communications. It represents an agreement between the communicating devices. Without a protocol, two devices are connected but may not communicating with each other.

Teacher Point

Teacher should explain some advantages of computer network over standalone computers.

5.1.2 MODES OF NETWORK COMMUNICATION

Modes of network communication refer to the methods or the ways information is transmitted from one place to another.

The following are different modes of data communication

- Simplex, Half-duplex and Full-duplex
- Synchronous and Asynchronous

i. Simplex, Half-duplex and Full-duplex communication modes

Simplex mode

In Simplex mode, the communication takes place in only one direction. In this mode communication is unidirectional, i.e. the communication can only take place in one direction and it is not possible for the receiver to send data back. For example data being sent to an electronic notice board found in train stations and Airports.

Radio and television broadcastings are also examples of simplex transmission. Transmission of information from a computer to a printer is also in one direction, as shown in Fig. 5.3.

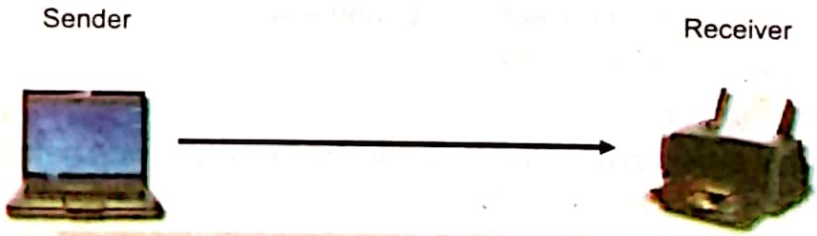


Fig.5.3 Simplex mode of data Communication

Half-duplex mode

In half-duplex mode, the communication takes place in both the directions but not at the same time. The signal can only be sent or received at one time. A common example of this type of communication is the use of walkie-talkies, where each of the persons communicating must indicate when they have finished speaking. Half-duplex transmission is used also in transaction-oriented systems, for example communication between a computer and credit card machine as shown in the Fig.5.4.

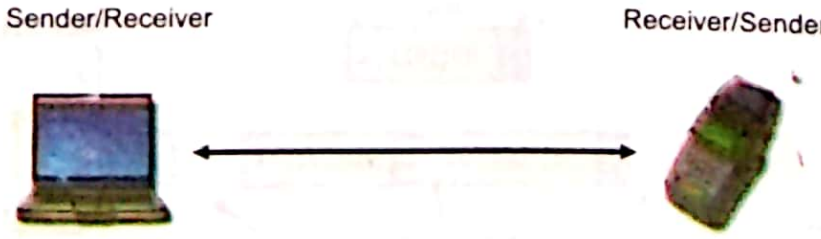


Fig.5.4 Half-duplex mode of data communication

Full-duplex mode

In full-duplex mode, the communication takes place in both the directions at the sam time. In this mode, both sender and receiver can send and receive the data simultaneously, fo example two or more computers connected to a network device such as a switch that provide full duplex activity. It is the fastest bi-directional mode of communication. The full-duplex mod is like a two way street, with traffic flowing in both directions at the same time.

One common example of full-duplex communication is the telephone network. When tw people are communicating by a telephone line, both can talk and listen at the same time. Als full-duplex mode is the most suitable for data communication between computers as shown o Fig. 5.5.

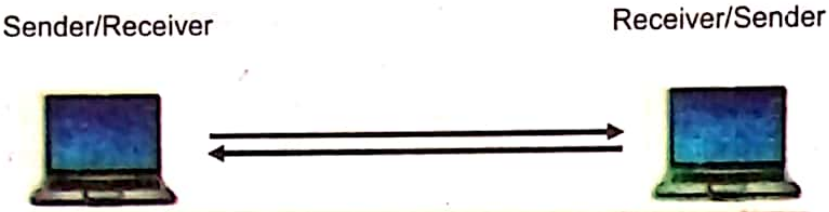


Fig.5.4 Full-duplex mode of data communication

ii. Asynchronous and Synchronous Transmission

Asynchronous and Synchronous Transmissions are the two different methods which ar used for transmitting characters between components within a computer or from computer t other devices such as printer, modem, etc.

Asynchronous Transmission

In asynchronous transmission, the time interval between two characters is variable an not fixed as shown in Fig.5.5. The computer devices can exchange information at their own rat slow or fast. Start and Stop bits are used in asynchronous transmission. These bits provid timing (synchronization) for the connection between the sender and the receiver. The start b tells the receiver that a character is coming and stop bit indicates that the transmission o character has ended. This type of transmission is ideal for slow-speed communication whe gaps may occur during transmission. Example of asynchronous transmission is keyboard dat transmission.

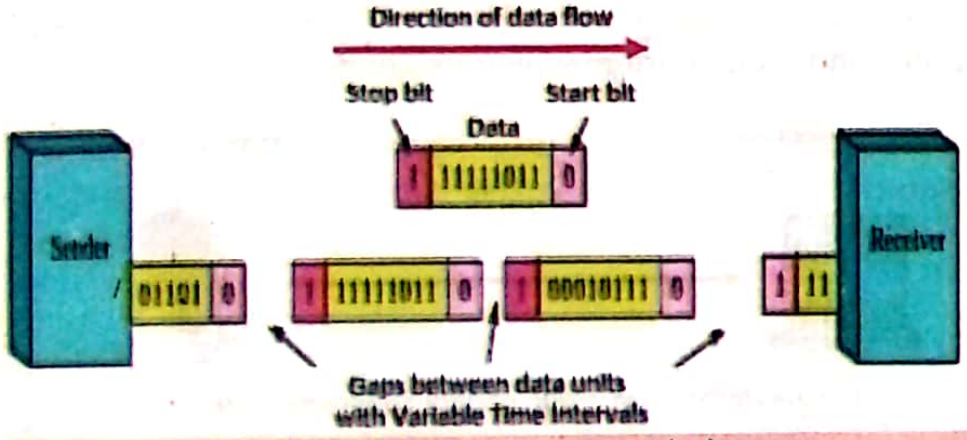


Fig.5.5 Asynchronous transmission

Synchronous Transmission

In synchronous transmission, the time internal between two characters is always the same as shown in Fig.5.6. In this method two communicating devices are synchronized and they continue to send characters in order to remain synchronized, even if there is no data to be transmitted. A special "idle" character is sent when there is no data for transmission. It does not require transmission of start and stop bits. It sends data as one long bit stream or block of data and each bit is sent one after the other. The receiver counts the bits and reconstructs the sent information in bytes. It is essential that timing is maintained as there are no start and stop bits and no gaps. Accuracy is dependent on the receiver keeping an accurate count of the bits as they come in.

Synchronous transmission is faster than asynchronous because fewer bits have to be transmitted; i.e. only data bits and no extra control bits are sent. The best example of synchronous transmission is the data transmission between devices in network communications links.

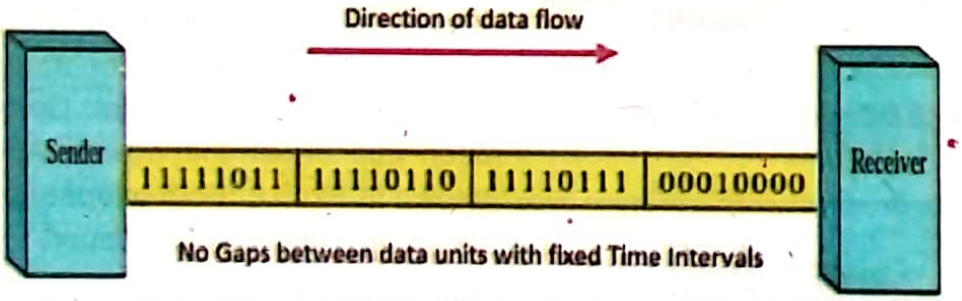


Fig.5.6 Synchronous transmission

5.1.3 COMMUNICATION MEDIA

In network communication system, ccommunication media are the links that provide paths for communicating devices. Communication media is used to transmit data from one network device (also called a node) to another. There are two main categories of communication media.

- Guided Communication Media
- Unguided Communication Media

Guided Communication Media

It is also called physical or bounded or wired communication media. In this type of media signals pass through a physical path. It uses cables that guide the data signals along a specific path. The following are some important guided media.

- Telephone Cable
- Twisted Pair Cable
- Coaxial Cable
- Fibre Optic Cable

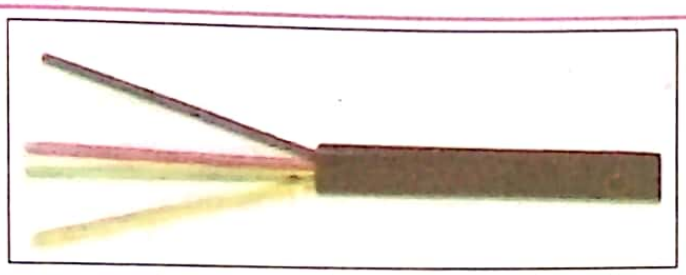


Fig.5.7 Telephone Line

Telephone Cable

Standard telephone cable is widely used as communication lines. Telephone lines are particularly useful to the user of data communication because the complex network of lines that has already been established allows data to be transmitted to any location in the world. The disadvantage of telephone line is that transmission speed is very slow. Therefore, its use for data communication is slowly declining. A telephone line is shown in Fig.5.7 with four cables.

Coaxial Cable

It is mainly used for long distance transmission. It can transmit data at much higher rate of 10 to 100 megabits per second. They are also used by telephone companies to transmit data over long distance.

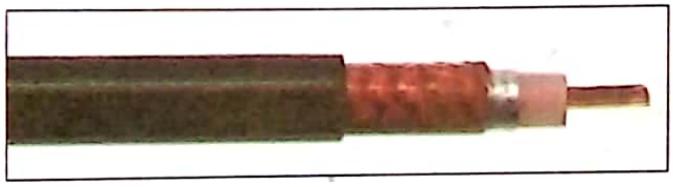


Fig.5.8 Coaxial cable

Coaxial cables are packed into a very large cable that can handle hundreds of thousands of telephone calls at the same time. Coaxial cable provides high quality data transmission without distortion or loss of signal. Coaxial cables have been laid under the ocean. A coaxial cable is shown in Fig.5.8. Both telephone line and coaxial cables are made up of copper.

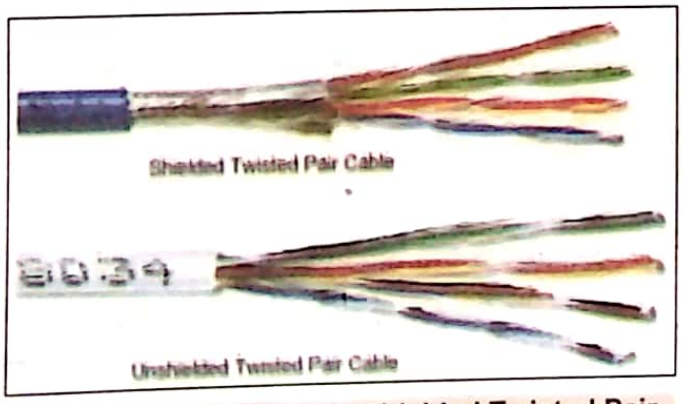


Fig. 5.9 Shielded and Unshielded Twisted Pair

Twisted Pair Cables

Twisted pair cables are twisted together in pairs. It provides shielding from outside interference. Cables with a shield are called Shielded Twisted Pair (STP) cables. Cables without shields are called Unshielded Twisted Pair (UTP) cables. These cables are shown in Fig.5.9.

Fibre Optic Cable

It is new technology that is replacing the conventional cable in communication systems. Fibre optic cable is smooth hair-thin strands of transparent material that transmits light waves at high speed. Fibre optic cables are shown in Fig.5.10.

The main advantage of fibre optic cable over wire cables includes weight and size reduction and increased speed of transmission. Fibre optic cable is not affected by electromagnetic interference. Therefore, noise and distortion are reduced. Fibre optic cable can transmit both voice and digital data.

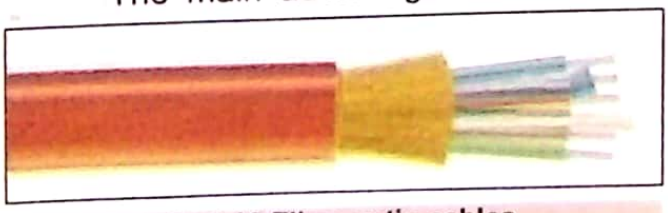


Fig.5.10 Fibre optic cables

Unguided Media

It is also called unbound or wireless media. In this type of communication media transmission takes place through open air. They are not guided through any specific path. The following are important unguided media.

Microwave Transmission

Microwave transmission signals travel through open space much like radio signals as shown in Fig.5.11. Microwave systems transmit information with transmitters which are normally installed on high buildings, mountains tops or high towers. Long distance microwave channels consist of a series of relay stations (boosters) spaced approximately 30 miles apart. Two stations must be within sight of one another. For transmitting information long distances, signals are amplified and retransmitted from station to station.

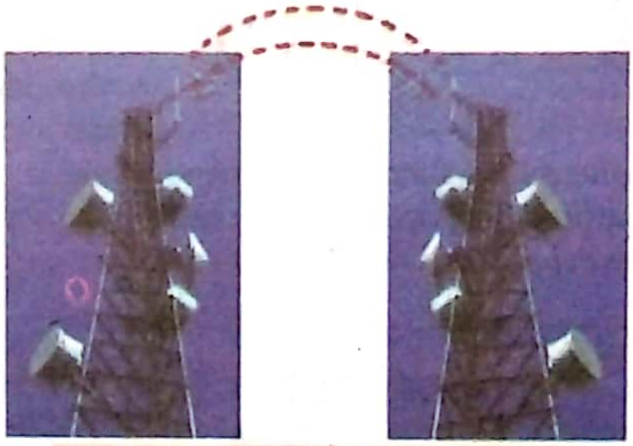


Fig.5.11 Microwave Transmission

Communication Satellites

Satellite is a relay station positioned approximately 22,000 miles above the earth. It orbits around the earth with exactly the same speed as the rotation speed of earth. Earth stations beam signals to the satellite as shown in Fig.5.12. The satellite amplifies and retransmits the signals to another earth station which can be located thousands of miles away.

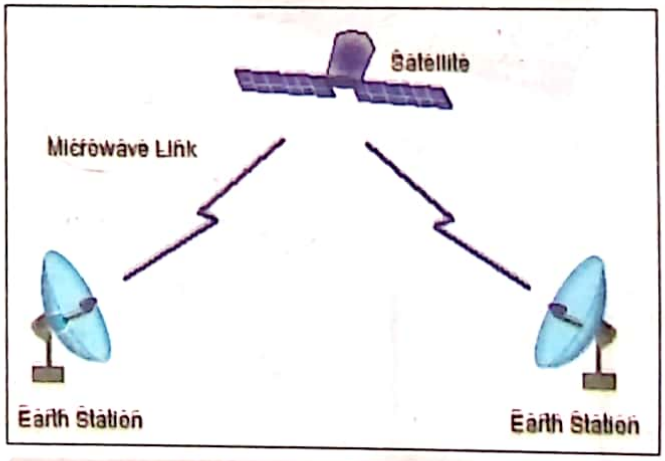


Fig.5.12 Satellite communication

Satellite communication is ideal for long distance communication. Transmission by satellite allows large amount of data to be sent long distance at rapid speeds. Its use has increased dramatically in recent years. However, a major drawback of satellite communication has been the high cost of placing the satellite into its orbits. These satellites are launched either by rockets or by space shuttles

5.1.4 COMMUNICATION DEVICES

A device that is used in telecommunication systems for transmitting data from one location to another is known as communication device.

Commonly used communication devices are: Hub, Switch, Router and Gateway.

Teacher Point

Teacher should explain different types of networks with diagrams.

Hub

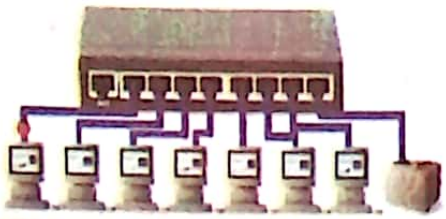


Fig.5.13a 8 Hub

Hub is a connectivity device used in LAN. It connects multiple LAN devices on one network and makes them act together as a single network. A hub is non-intelligent device and sends output to all the devices on the network. A hub has multiple input/output (I/O) ports, in which an input in one port results in it being an output in all the other ports, except the port where it was input. In layman's terms, a hub connects many networks into one, where a data packet that is sent by one networks, is copied and pasted to all network ports, making it so that every port can see that data packet.

Switch

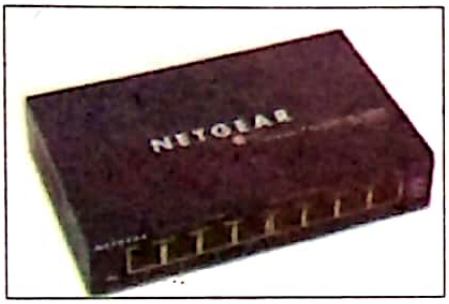


Fig.5.13 8 Port Switch

Switch is a networking device that performs the same job as the hub but are considered as a more intelligent hub as it gathers information about the data packets it receives and forwards it to only the network that it was intended for. A switch inspects data packets as they are received, determines the source and destination device of each packet and forwards them appropriately. A packet is a basic unit of communication over a computer network. When data is transmitted, it is broken down into packets which are reassembled to the original form once they reach the destination.

Router

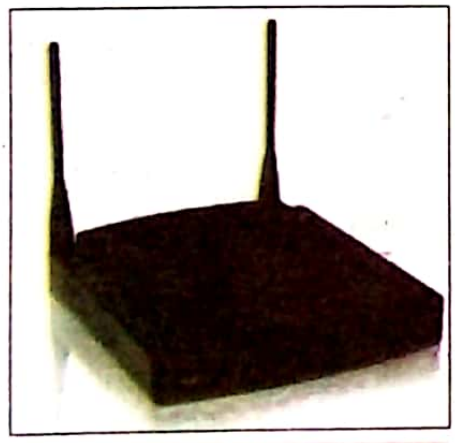


Fig.5.14 Wireless Router

Router is a communication device which is used to connect two or more networks. Today, most of the networks are connected to Internet. When the computer is sending data to another computer on the Internet, router receives the data packets, looks for the remote computer address and forwards it to a computer that is closer to the remote computer. It forwards the data packets by selecting the best path-way based on network traffic. Many routers take part in transmitting the data packets from one location to another. A wireless router is shown in Fig.5.14.

Gateway

Fig.5.15 Gateway Device

Gateway is a device that is used to connect a network to another network that uses different protocols. If we have to link different kinds of networks, such as a network of IBM mainframe computers and a network of PCs, we might have to use a gateway. Gateways change the format of the data packets but not the contents of the message, to make it conform to the application program of the remote computer.

5.1.5 NETWORK ARCHITECTURE

Network architecture is the design of a communication system. It includes hardware devices (such as routers and switches), cabling, network topology and physical and wireless connections. Computer networks consist of server computers and client computers.

Server Computer: A computer on the network that shares resources for others to use is called a server computer or simply server. Shared resources include information, software, printer, plotter, Internet connection, hard disk, etc.

Client Computer: A computer on the network that accesses resources that are shared by other computers is known as client computer or simply client.

The two commonly used network architectures are:

- Client/Server Network
- Peer-to-Peer Network

Client/Server Networks

A computer network in which each computer on the network acts as either a server or a client is called client/server or dedicated server network. Each server computer on the network is called a dedicated server. Servers are not used as client computers. Fig.5.16 illustrates how a dedicated server network may be designed. The computer at the top of the figure is the dedicated server, sharing files and applications. The remaining computers in the illustration are clients that access resources shared by the server. Similarly, in a dedicated server network, client computers never act as servers.

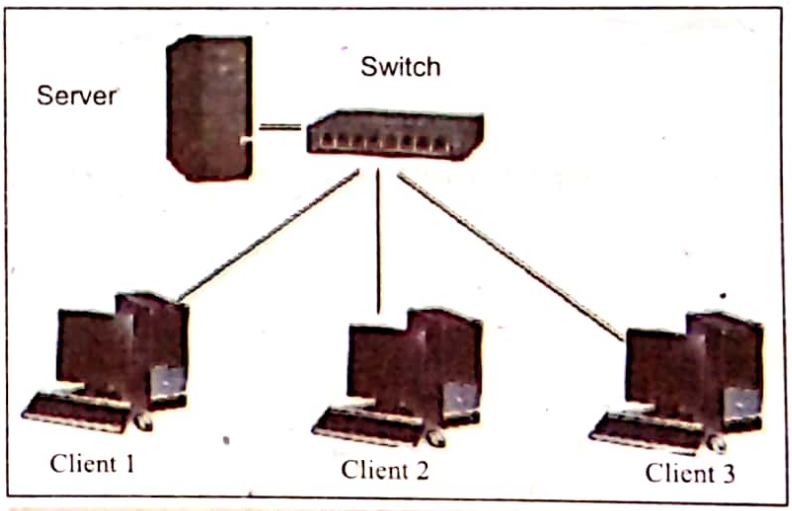


Fig.5.16 Client/Server Network

Client/Server network includes one or more computers that are dedicated to acting as servers. The servers are optimized to provide quick access to shared network resources. Servers also provide centralized security to ensure that resources are not accessed by unauthorized users.

Because the client/server approach centralizes control of data and other shared resources, one person or group is typically responsible for administering the network.

Peer-to-Peer Networks

In Peer-to-Peer networks, every computer is capable of playing the role of client, server or both at the same time. In this network each computer on the network is referred to as peer. In a peer-to-peer network, a peer computer can act as both a server and a client at the same time. A peer computer on your desktop can share files and printers with other computers

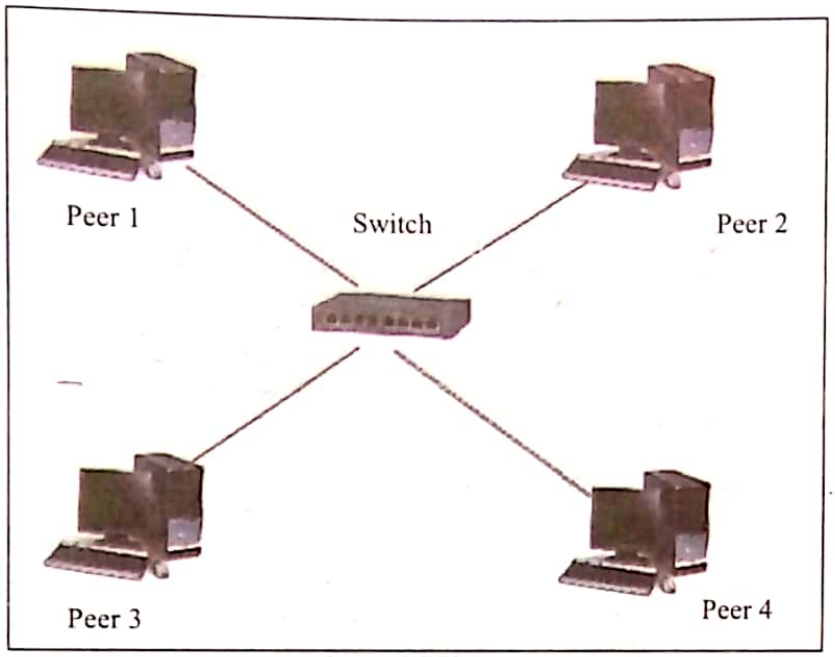


Fig.5.17 Peer-to-Peer Network

and it can simultaneously access other shared resources on the network. A conceptual view of a peer-to-peer network is shown in Fig.5.17.

Peer-to-peer networks tend to be relatively small. Most of these networks fall to range between two and ten computers. Large peer-to-peer networks become difficult to manage, because so many network administrators control sharing and maintaining shared resources.

5.1.6 TYPES OF NETWORKS

The following are different types of networks based on the size and physical area they cover.

Local Area Networks

A Local Area Network (LAN) spans a limited physical area. It is confined to a single building or a group of buildings. LANs are used for sharing applications, printers, group scheduling, e-mail, project tracking and other tasks. A LAN is shown in Fig.5.18.

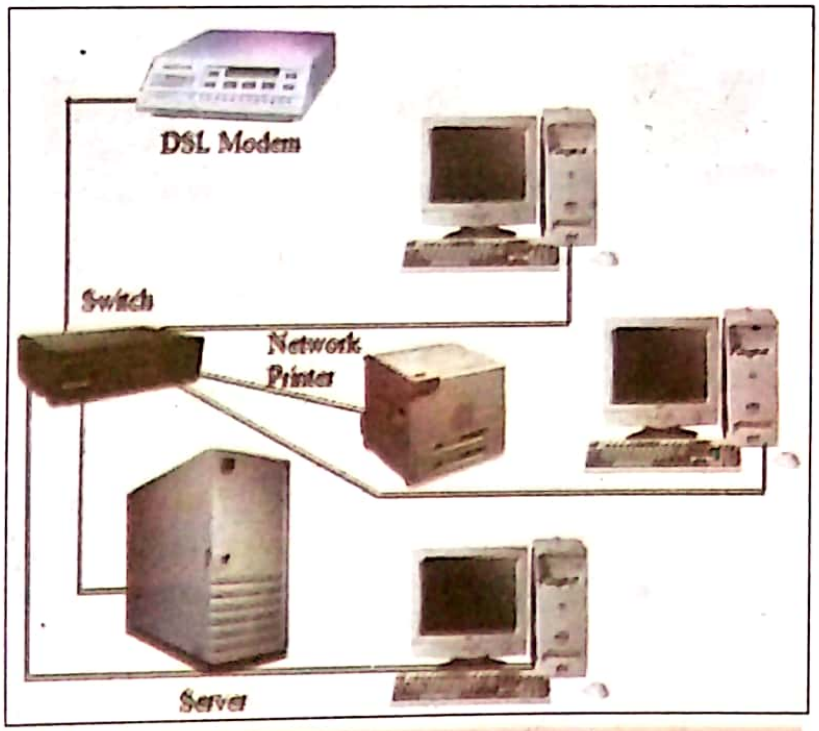


Fig.5.18 Local Area Network

Characteristics of LAN

- Spans a small physical area.
- Uses high-speed wired/wireless connections between computers.
- It is a very reliable network. Communication errors are very rare.
- It consists of a limited number of computers.

Wide Area Networks

A Wide Area Network (WAN) spans a large physical area, connecting several sites of an organization across cities, countries and continents. Because of the longer distances involved, WANs are sometimes referred to as long-haul networks.

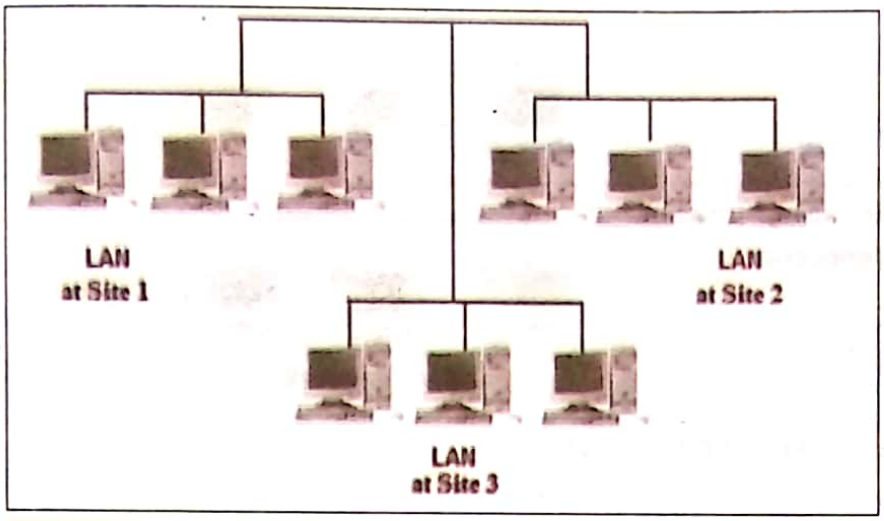


Fig.5.19 A Wide Area Network

A WAN is often made up of two or more LANs connected together as shown in Fig.5.19. For example, you might have a LAN at each site of your organization and each of those LANs might be connected together to form a WAN.

Characteristics of WAN

- Spans a large physical area. It can be worldwide like Internet.
- Communication speed is slow compared to LAN.
- Connects computers through public networks, leased lines or satellites.
- Connects multiple LANs.
- Sometimes communication errors occur.

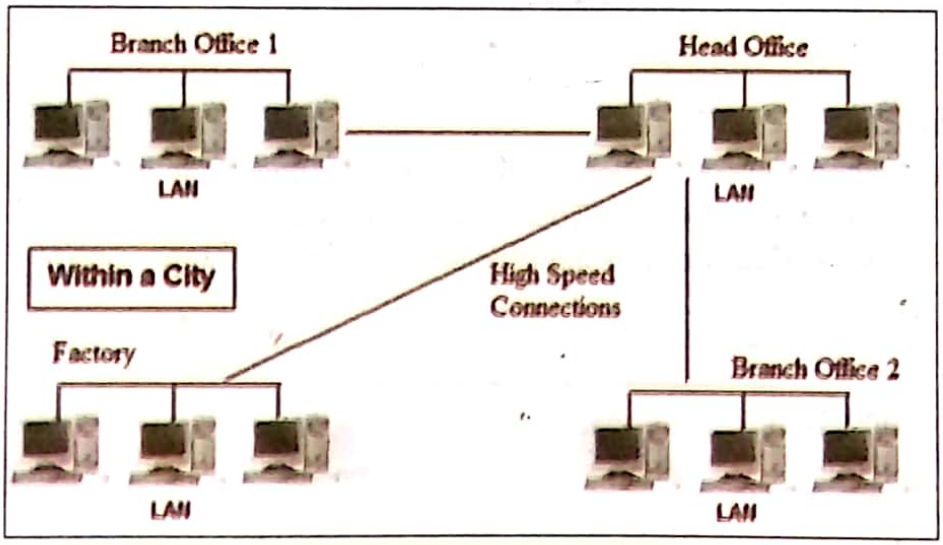


Fig.5.20 Metropolitan Area Network

Metropolitan Area Network

Metropolitan Area Network (MAN) can span from several buildings or a large campus to entire cities. MAN is used by many organizations. It also connects a number of local area networks with high-speed communication lines.

Characteristics of MAN

- It is larger than a LAN and smaller than a WAN. Covers an area of between 5 to 50 km diameter.
- Uses fiber optic cable or microwave transmission.
- Provides high-speed communication.
- Used by telephone companies, Internet Service Providers and cable TV companies.

Virtual Private Network

Virtual Private Network (VPN) is a computer network that provides remote access to individuals and offices to their organization's networks. It provides cheap communication by using public telecommunication infrastructure such as Internet instead of expensive leased lines.

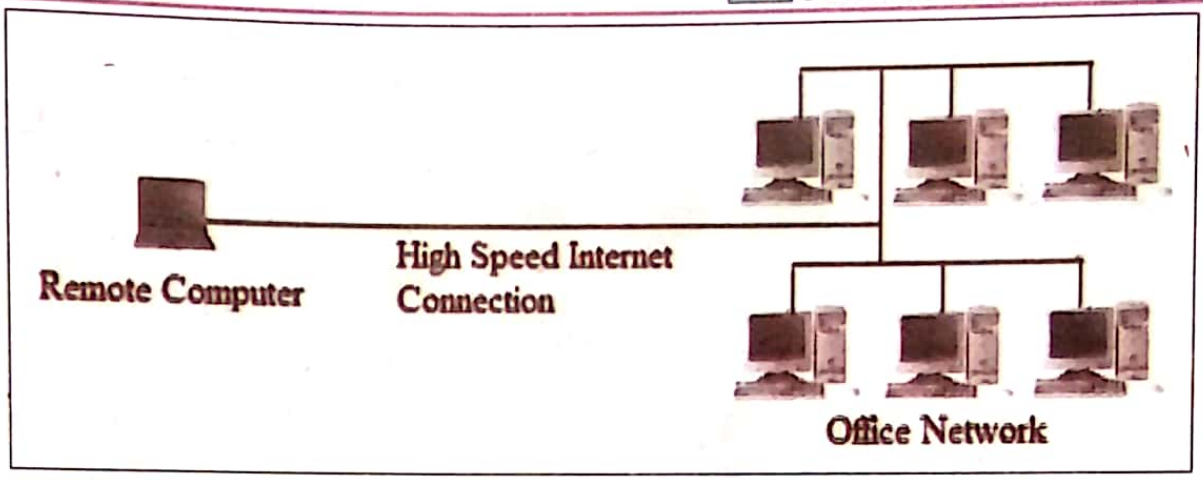


Fig.5.21 Virtual Private Network

It allows employees at home or on trip to connect their laptops into the computer as office through public telecommunication networks and do their work.

Characteristics of VPN

- It uses public networks such as Internet to connect computers.
- Provides secure remote access.
- Enables files sharing, video conferencing and similar network services.
- Provides cheap communication over long distance.

5.1.7 NETWORK TOPOLOGIES

The arrangement of network nodes and connections between them is called the network's topology. A node represents any device on the network. Topology is simply a map of the layout of nodes and connections in the network. Four network topologies are popular today, namely, Bus, Star, Ring, and Mesh.

Bus Topology

Bus network topology connects each node to the network along a single piece of cable, called a bus. Bus network topology is shown in Fig.2.24.

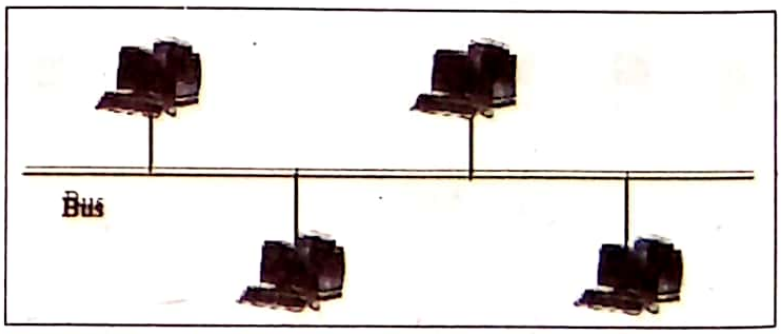


Fig.5.24 Bus network topology

Features of Bus Topology

- Suitable for a small network.
- Easy to connect a computer or a peripheral device to the network.
- Requires less cable to implement.
- Terminator is installed at each end of the cable to prevent signals from reflecting back onto the bus and cause errors. Terminator is a device that is attached to ground.

Teacher Point

Teacher may also use presentations or animations or videos for explanation.

Limitations of Bus Topology

- If the single cable is severed at any point, the entire network can go down.
- Difficult to identify the problem if the entire network goes down.

Not suitable for large network.

Star Topology

In a star network topology, each network node is connected to a central device called a hub. Large networks can require many hubs and hubs can be connected to each other to create a single large network. Star network topology is shown in Fig.5.22.

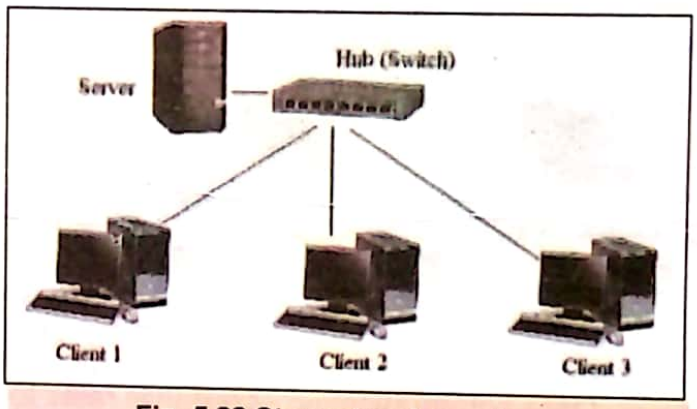


Fig. 5.22 Star network topology

Features of Star Topology

- It is suitable for both small and large networks.
- Easy to install and wire.
- Easy to detect and remove faults.
- Failure of cable does not stop functioning of the entire network.

Limitations of Star Topology

- Failure of the hub causes the entire network to go down.
- Expensive topology to implement. Lengthy cable with a hub is required to install star topology

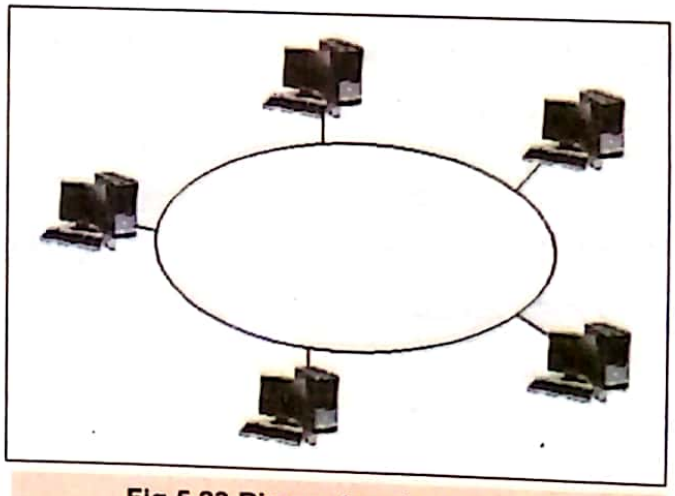


Fig.5.23 Ring network topology

Ring Topology

Ring topology is shaped just like a ring. It is made up of an unbroken circle of network nodes. Ring network topology is shown in Fig.5.23.

Features of Ring Topology

- Each node is directly connected to the ring.
- Easy to install and wire.
- Data on the network flows in one direction.
- Not costly to implement.

Limitations of Ring Topology

- If the ring is broken at any point, the entire network stops functioning.
- Slower than other network topologies.

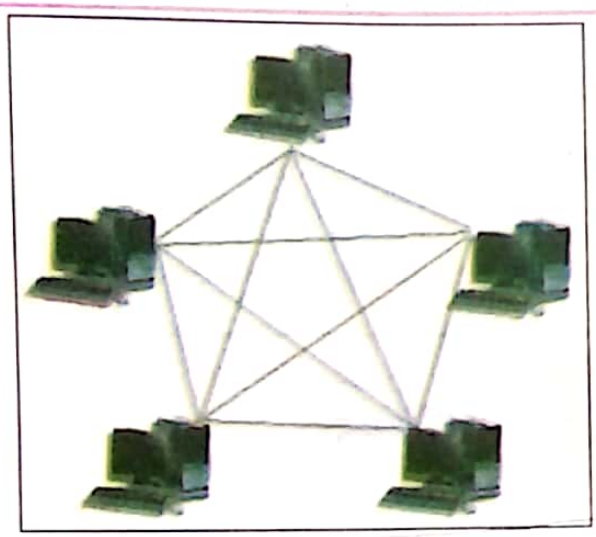


Fig.5.25 Mesh network topology

Mesh Topology

In mesh topology, each node is directly connected to all the nodes as shown in Fig.5.25.

Features of Mesh Topology

- Most reliable network topology.
- Data can be routed around failed computers or busy ones.
- Can manage high traffic.

Limitations of Mesh Topology

- Most expensive topology to implement.
- Setup and maintenance is very difficult.

5.2 DATA COMMUNICATION STANDARDS

Data communication standards refer to hardware and software specifications that make communication between different computer systems possible.

5.2.1 PURPOSE OF COMMUNICATION STANDARDS

Any computer or device in the network can communicate with any other computer or device by following some rules. These rules are called communication standards. Communication standards are needed so that different computer networks can communicate with each other.

5.2.2 OSI MODEL

The International Standards Organization (ISO) based in Geneva, developed standards for international and national data communications. In the early 1970s, ISO developed a standard model of a data communication system and called it the Open Systems Interconnection (OSI) model.

The OSI model consists of seven layers. Each layer performs a specific task during data communication.

In OSI model, control is passed from one layer to the next, starting at the application layer in one station and proceeding to the bottom layer (the physical layer), over the physical link to the next station and back up to the application layer. This process is in shown in Fig.5.26.

The seven layers of OSI model are described below.

Layer 7 – Application Layer

Application Layer provides services to end-user. It interacts with the operating system or application software whenever the user wants to send files, read messages or perform other network related activities.

Layer 6 – Presentation Layer

Presentation Layer takes the data provided by the Application Layer and converts it into a standard format that the other layers can understand. At the receiving end it also formats the information so that it looks the way the user can understand.

Layer 5 – Session Layer

Session Layer performs functions that enable two applications or two pieces of the same application to communicate across the network. It performs security, name recognition, logging and other similar functions. It also establishes, maintains and ends communication with the receiving computer.

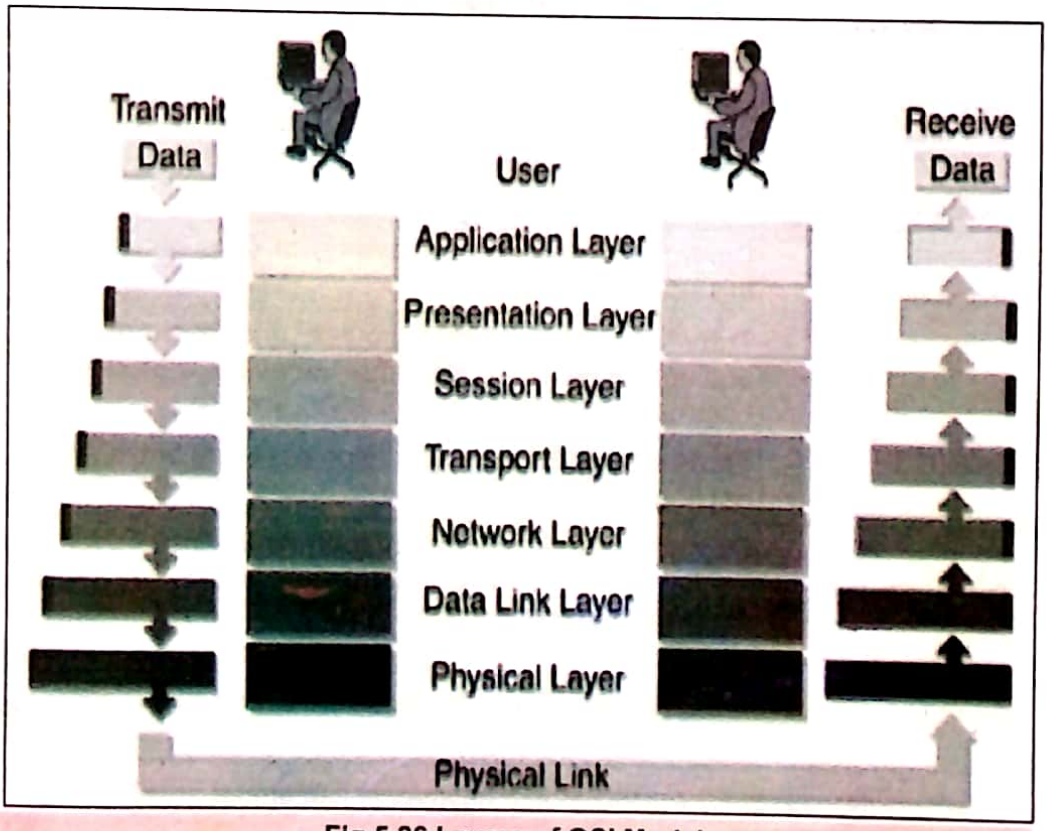


Fig.5.26 Layers of OSI Model

Layer 4 – Transport Layer

Transport Layer establishes connections between two computers on the network. It handles quality control by making sure that the data received is in the right format and the right order.

Layer 3 – Network Layer

Network Layer decides which physical path-way the data should take to reach the destination. The communication device **Router** works in network layer.

Layer 2 – Data Link Layer

Data Link Layer defines the format of data on the network. This layer converts the data into packets and checks them before putting them on the path-way. The communication device Switch works in this layer.

Layer 1 – Physical Layer

Physical Layer defines cables and signalling. It provides hardware means such as cables and connectors for sending and receiving data. Cables, hubs and repeaters work in this layer.

5.2.3 PROTOCOLS AND DEVICES USED AT VARIOUS LAYERS OF OSI MODEL

A **protocol** is a set of rules and conventions that govern how computers exchange information over a network medium. A protocol implements the functions of one or more of the OSI layers as shown in Table 5.1.

Layers of OSI Model	Protocol Name	Protocol Function	Device Used
Physical Layer	X.25 & IEEE 802	Provides hardware such as cables and connectors for sending and receiving data.	Cables and Connectors
Data Link Layer	X.25 & IEEE 802	Places data packets on to the path-way for transmission.	Switches & NICs
Network Layer	Internet Protocol	Controls routing and forwarding of data between the source and destination.	Router
Transport Layer	TCP	Transfers data between source and destination and is responsible for error recovery and flow control.	Router and Gateway
Session Layer	NetBIOS	Starts and stops communication sessions between applications.	Gateway
Presentation Layer	Windows O.S.	Converts data into a format that can be carried by the lower layer or converts data into a form that the application layer can understand at the receiving end.	Gateway
Application Layer	HTTP	Provides interaction between the end user and software	Gateway

Table 5.1 Protocols and devices of OSI Model

5.3 TCP/IP

Communication between computers on a network is done through protocol suits. TCP/IP is the most widely used protocol suite for communication. TCP/IP was developed by US Department of Defense (DoD) in 1969. The most important capability of TCP/IP is that it provides communication between two or more computer systems used for communication over the Internet.

5.3.1 TCP/IP PROTOCOL

Protocol Suite is a set of communication protocols used on Internet and many other computer networks. It is commonly known as TCP/IP protocol because its most important protocols are Transmission Control Protocol (TCP) and Internet Protocol (IP).

The architecture of TCP/IP protocol describes the function of its each layer during communication between computers on the Internet. Every computer on Internet has a unique number assigned to it called the IP address. The IP address recognizes a particular computer out of millions of computers connected to the Internet.

TCP/IP Architecture

TCP/IP protocol architecture has four layers that transmit information from one computer to another over the Internet. These layers pass information from the application layer to the physical network layer. The four layers of TCP/IP protocol architecture are:

- Application Layer
- Transport Layer
- Network Layer
- Network Access Layer

TCP/IP Ports and Applications

When an application on the computer sends or receives data over the Internet, it sends data to an IP address and a specific port on the remote computer and also receives the data on a port on the receiving computer. There are a total number of 65,535 TCP/IP ports. The Internet Assigned Numbers Authority (IANA) is a global organization that is responsible for registration of port numbers for common Internet services.

5.3.2 TCP/IP AND OSI MODEL COMPARISON

The following chart clears the difference between the two models.

	TCP/IP MODEL	OSI MODEL
1	TCP/IP stands for Transmission Control Protocol/ Internet Protocol	OSI stands for Open system Interconnect
2	TCP/IP consists of 4 Layers	OSI Model consists of 7 Layers
3	It was developed by US Department of Defense (DoD)	It was developed by ISO (International Standard Organization)
4	It is a client server model used for transmission of data over the Internet	It is a theoretical model which is used for computing system
5	TCP/IP is an implementation of OSI model	OSI is a reference model
6	The TCP/IP suite is based on protocols	OSI model is layer based model

Comparison between TCP/IP Model and OSI Model is also shown in Fig.5.27.

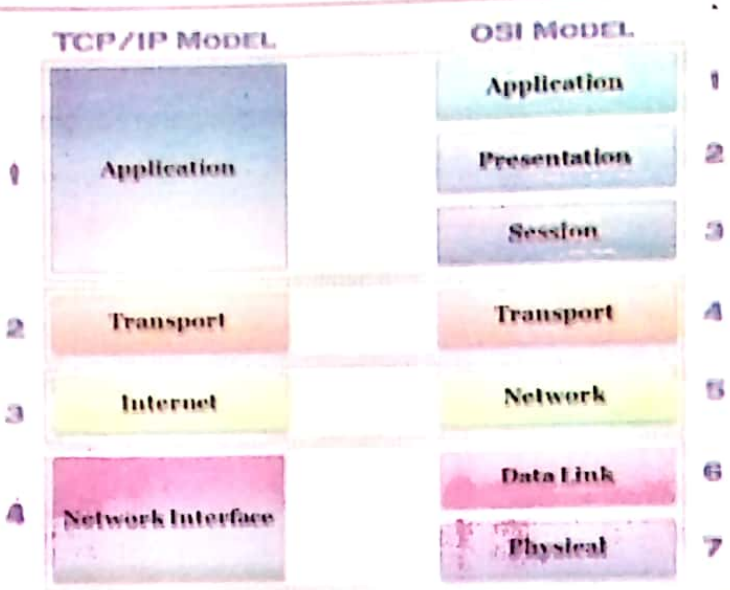


Fig.5.27 Comparison between TCP/IP and OSI Models

5.3.3 CIRCUIT SWITCHING AND PACKET SWITCHING NETWORKS

Circuit Switching Network

In circuit switching network, a physical connection must be established through the network. The data is transmitted through several switches. When transmitting data over a circuit switched network, a connection is established and kept open for the duration of communication. The circuit switched networks require dedicated point-to-point connection between the subscribers and no other network traffic can use the communication line. It provides a fixed data rate for both transmission and reception. An example of circuit switched network is the telephone network.

Packet Switching Network

In packet switching network no physical connection is established between the two subscribers like circuit switching network. All the data that is to be transmitted is broken down into small blocks called packets. These packets include both the source and destination address. They are passed by the source computer to its local Packet Switching Exchange (PSE). On receipt of each packet, the PSE first stores the packet and then inspects the destination address it contains. Each PSE contains a routing directory specifying the outgoing links' transmission paths to be used for each network address. The PSE forwards the packet on the appropriate link. When received, packets are reassembled in the proper sequence to make up the message.

5.3.4 IP ADDRESSING SCHEMES

An IP address is a 32-bit number that uniquely identifies a host (computer or other device, such as a printer or router) on a TCP/IP network. IP addresses have two parts. The first part identifies the network to which the computers are connected and the second part identifies the computers or hosts on the given network.

Network Number	Computer/Host Number

All the computers on a given network share the same network number but must have a unique computer/host number. Similarly, any two computers on different networks must have different network number but may have the same computer/host number.

An IP address is made up of 32 bits. The 32 bits are broken down into four octets. One octet is equal to 8 bits. Each octet is converted to decimal and separated by a dot. Therefore, an IP address is expressed in dotted-decimal format. For example, Fig.5.14 shows an IP address with equivalent dotted-decimal notation.

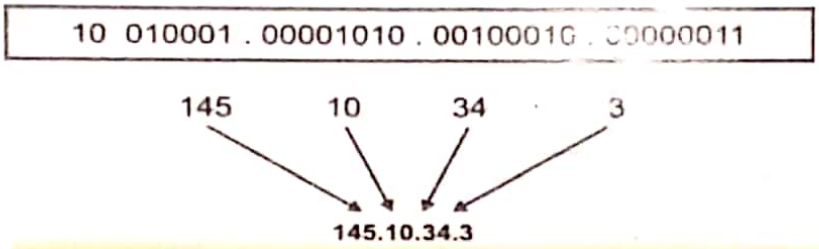


Fig. 5.14 An IP Address expressed in decimal-dotted notation

Subnet Mask

The second item, which is required for TCP/IP to work, is the subnet mask. The subnet mask is used by the TCP/IP protocol to determine whether a computer/host is on the local subnet or on a remote network. This information is supplied in another 32-bit number called a subnet mask. In this example, the subnet mask is 255.255.255.0. It is not obvious what this number means unless you know that 255 in binary notation equals 11111111; so, the subnet mask is:

11111111.11111111.11111111.0000000

Lining up the IP address and the Subnet mask together, the network and host portions of the address can be separated:

11000000.10101000.01111011.10000100 – IP address (192.168.123.132)

11111111.11111111.11111111.00000000 – Subnet mask (255.255.255.0)

The first 24 bits (the number of ones in the subnet mask) are identified as the network address, with the last 8 bits (the number of remaining zeros in the subnet mask) identified as the host address.

Network Classes

All networks in use have different sizes. For example, a company that will have 50 computers, will not need a network of 5000 computers, And on the contrary, a company that needs 5000 computers does not need a network that can only hold 50 computers.

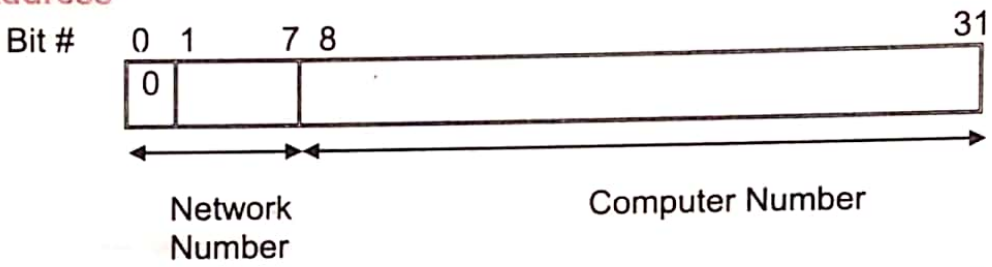
This is the main reason that engineers decided that IP address space should be divided in different classes in order to meet different size requirements of networks.

TCP/IP defines five classes of IP addresses: class A, B, C, D, and E. Each class has a range of valid IP addresses. The value of the first octet determines the class. IP addresses from the first three classes (A, B and C) can be used for host addresses. The other two classes are used for other purposes (class D for multicast and class E for experimental purposes).

Class	1st Octet Decimal Range	1st Octet High Order Bits	Network/Host ID (N=Network, H=Host)	Default Subnet Mask
A	1 – 126*	0	N.H.H.H	255.0.0.0
B	128 – 191	10	N.N.H.H	255.255.0.0
C	192 – 223	110	N.N.N.H	255.255.255.0
D	224 – 239	1110	Reserved for Multicasting	
E	240 – 254	1111	Experimental; used for research	

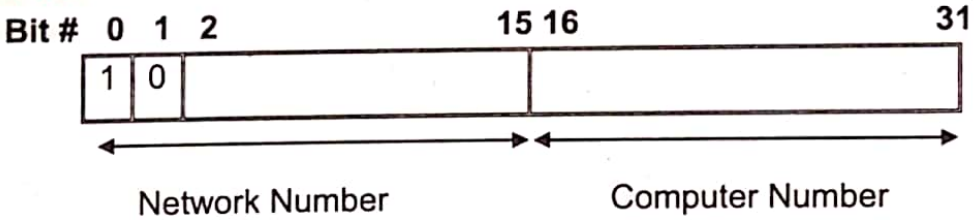
***Note:** Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback and diagnostic functions.

Class A Address



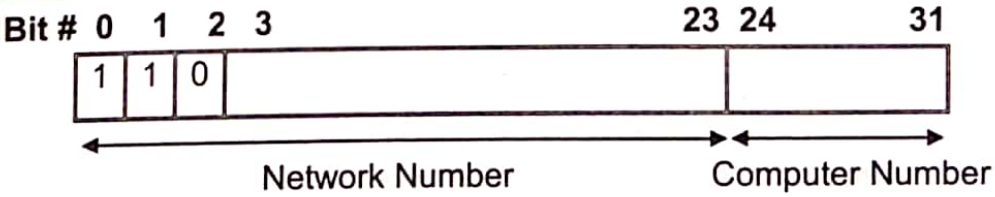
Class A networks use a default subnet mask of 255.0.0.0 and have 0-126 as their first octet. The address **10.52.36.11** is a class A address. Its first octet is 10, which is between 1 and 126, inclusive.

Class B Address



Class B networks use a default subnet mask of 255.255.0.0 and have 128-191 as their first octet. The address **172.16.52.63** is a class B address. Its first octet is 172, which is between 128 and 191, inclusive.

Class C address



Class C networks use a default subnet mask of 255.255.255.0 and have 192-223 as their first octet. The address **192.168.123.132** is a class C address. its first octet is 192, which is between 192 and 223, inclusive.

Teacher Point

- OSI model layers should be demonstrated through videos available on Internet (youtube.com).
- Teacher should give some home assignments to the students at the end of the chapter.

Key Points

- A computer network is an interconnection between two or more computers so that they can communicate with each other.
- Data communication consists of three basic components which are Sender, Medium and Receiver.
- Modes of data communication refer to the method or way information is transmitted from one place to another. There are three types of data communication modes which are simplex, half-duplex and full-duplex.
- In asynchronous transmission, the time interval between two characters is not fixed whereas in synchronous transmission it is fixed.
- Guided transmission media uses cables that guide the data signals along a specific path.
- Unguided transmission media transmits data signals through open air.
- A communication satellite is a relay station in the space that receives signals from ground antennas, amplifies them and then retransmits to another earth station which can be thousands of miles away.
- A Switch is a small device that connects multiple computers together in a LAN.
- A Router is a device that receives data packets and forwards them to a closer computer to the remote computer by selecting the best path-way based on network traffic.
- A Gateway is a device that is used to connect a network to another network that uses different protocols.
- A computer network in which each computer on the network acts as either a server or a client is called Client/Server Network.
- A computer network in which every computer is capable of playing the role of client, server or both at the same time is called Peer-to-Peer Network.
- A network that spans a limited physical area such as a building or a group of buildings is called Local Area Network (LAN).
- A network that spans large physical area, connecting several sites of an organization across cities, countries and continents is called Wide Area Network (WAN).
- A network that spans from several building or a large campus to entire city is called Metropolitan Area Network (MAN).
- A network that provides remote access to individuals and offices to their organization's network using public telecommunication infrastructure such as Internet is called Virtual Private Network (VPN).
- The arrangement of network nodes and connections between them is called network topology.
- The OSI Model was designed to facilitate creating system in which equipment from different venders can communicate with each other.

- TCP/IP was developed by Department of Defense, USA, to implement Transmission Control Protocol and Internet Protocol. It provides communication between two or more different computer systems.
- In a circuit switched network, a physical connection is established through the network for transmitting data.
- In a packet switched network, all the data that is to be transmitted is broken down into small blocks called packets. These packets are passed from the source computer to the destination computer through several Packet Switching Exchanges.
- IP addressing schemes are used in computer networks to identify a computer for communication.

Exercise

Q1. Select the best answer for the following MCQs.

i. In which communication mode data can be sent and received in both directions but not simultaneously?
   A. Simplex mode
   B. Half-duplex mode
   C. Full-duplex mode
   D. Synchronous transmission

ii. Which of the following network devices connects a network to another network that uses different protocol?
   A. Switch
   B. Gateway
   C. Router
   D. Modem

iii. Which of the following networks provides remote access to individuals and offices to their organization's network?
   A. LAN
   B. WAN
   C. MAN
   D. VPN

iv. In which topology a hub (switch) is used?
   A. Star topology
   B. Ring topology
   C. Bus topology
   D. Mesh topology

v. Which topology is most expensive to implement?
   A. Star topology
   B. Ring topology
   C. Bus topology
   D. Mesh topology

vi. Which layer of OSI Model decides which physical path-way the data should take to reach the destination?
   A. Data link layer
   B. Network layer
   C. Transport layer
   D. Session layer

vii. Which network layer performs security, name recognition, logging and similar functions?
   A. Transport layer
   B. Network layer
   C. Presentation layer
   D. Session layer

viii. Which of these cables transmits data using light waves?
   A. Twisted pair cable
   B. Coaxial cable
   C. Fibre optic cable
   D. Telephone line

ix. Which of these uses a start/stop bit for data transmission?

A. Asynchronous transmission
B. Synchronous transmission
C. Half-duplex transmission
D. Full-duplex transmission

x. Which bits are used at the start of a Class B IP address?

A. 0
B. 10
C. 101
D. 110

Q2. Write short answers of the following questions.

i. Define computer network.
ii. Define network communication and its basic components.
iii. Briefly describe the modes of network communication.
iv. Differentiate between asynchronous and synchronous network transmissions.
v. Differentiate between server and client computers.
vi. Differentiate between LAN and WAN.
vii. What is OSI Model?
viii. Compare TCP/IP Model with OSI Model.
ix. Differentiate between circuit switched and packet switched networks.
x. Briefly describe IP Addressing.

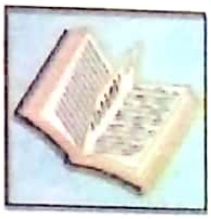
Q3. Write long answers of the following questions.

i. Explain different types of guided media.
ii. Explain microwave and satellite communications.
iii. Write notes on switch, router and gateway.
iv. Explain in detail Client/Server and Peer-to-Peer networks.
v. Define network topology and explain its types.
vi. Describe briefly the seven layers of OSI Model.
vii. Describe the four layers of TCP/IP Model.

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. Clint-Server and Peer – to – Peer networks should be demonstrated through video/animation.
2. Sharing of files/folders, printers and Internet connection should be demonstrated.
3. Use of switch and router is to be demonstrated,
4. Use of TCP/IP protocol and IP addressing is to be demonstrated through video/animation.



6. WIRELESS COMMUNICATIONS

After completing this lesson, you will be able to:

- Define wireless network
- Know the advantages and disadvantages of wireless networks
- Define radio signals, radio transceiver, access point and line of sight communication
- Differentiate between short distance and long distance wireless communication
- Describe types of short distance wireless technologies (Wi-Fi, Wi-Max, Bluetooth and Infra-red)
- Describe types of long distance wireless communication (Cellular Communication and Global Positioning System)
- Define mobile communication
- Identify features and limitations of mobile communication system
- Know the architecture for communication over mobile devices

Reading

UNIT INTRODUCTION

Wireless communication is an important area in telecommunications and networking. This unit is dedicated to wireless communication systems. It defines commonly used wireless communication terminology and presents contents about the types of signals, devices and architecture used for creating wireless communication networks. It defines short distance and long distance wireless communication and describes the technology used for it.

6.1 INTRODUCTION

Wireless communication is a term used to describe communications between two or more devices without any physical connection. The widespread use of mobile telephone, various satellite services, and now the wireless Internet and wireless LAN's are generating incredible changes in telecommunications and networking. Wireless communication refers to technology

Teacher Point

Before starting the chapter, the students could be encouraged to explain what they understand about the Wireless communication.

that transmits information over short or long distance without using connecting wires. It is an alternative to using network cables. The demand for wireless communication is rapidly increasing today.

6.1.1 WIRELESS NETWORKS

The term wireless refers to the communication or transmission of information over a distance without requiring wires, cables or any other electrical conductors. Wireless communication networks is one of the important mediums of transmission of data or information to other devices. In wireless networks the information is transmitted through the air, without requiring any cables, by using wireless network technology. Some important wireless technologies are Satellite, Microwave, Wi-Fi, WiMAX, Infrared and Bluetooth. Today, the term wireless refers to a variety of devices ranging from smart phones to laptops, tabs, computers, printers, etc.

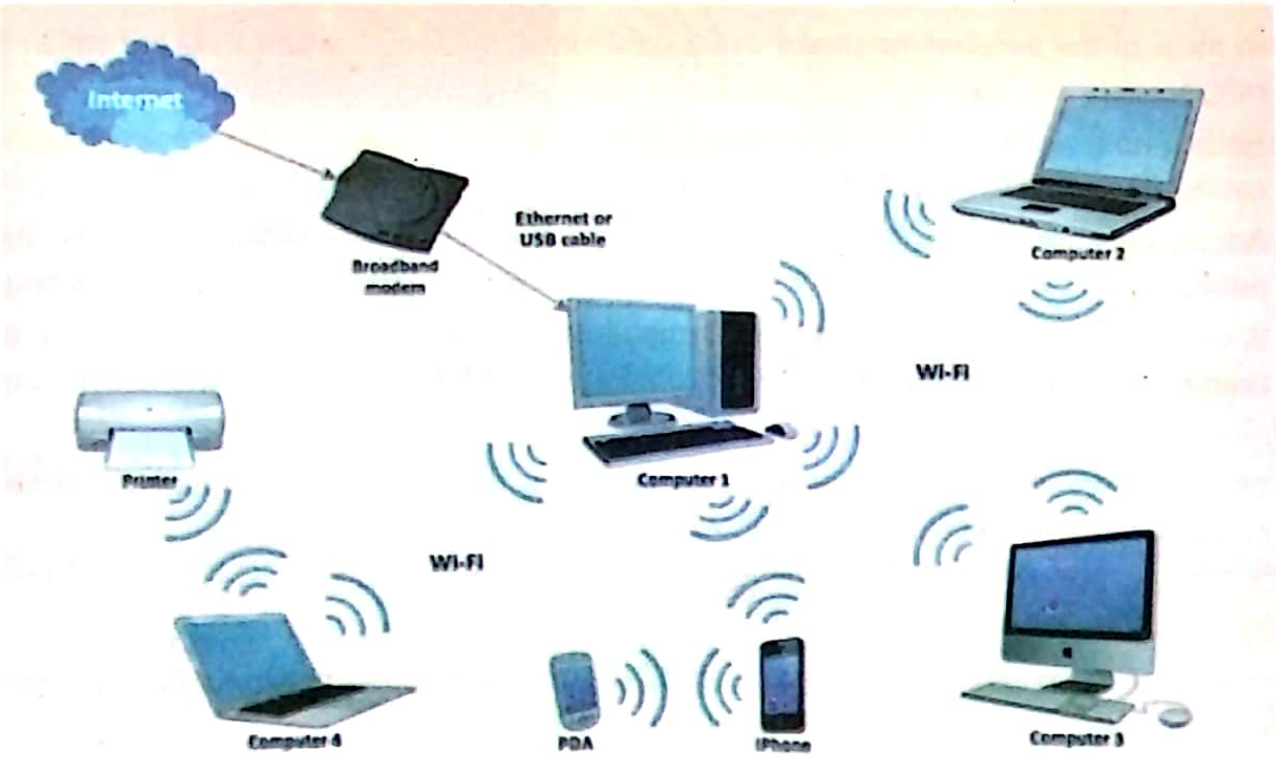


Fig. 6.1 Wireless Network

A wireless network enables people to communicate and access applications and information without wires. This provides freedom of movement and the ability to extend applications to different parts of a building, city, or nearly anywhere in the world. Wireless networks allow people to interact with e-mail or browse the Internet from a location that they prefer.

Many types of wireless communication systems exist, but a distinguishing attribute of a wireless network is that communication takes place between computer devices. These devices include personal digital assistants (PDAs), laptops, personal computers

(PCs), servers, and printers. Computer devices have processors, memory, and a means of interfacing with a particular type of network. In most cases, wireless networks transfer data, such as e-mail messages and files, but advancements in the performance of wireless networks is enabling support for video and voice communications as well. A wireless network is shown in Fig.6.1.

6.1.2 ADVANTAGES AND DISADVANTAGES OF WIRELESS NETWORKS

Advantages of Wireless Networks

- Wireless networks can easily add users without having to change the physical connection.
- Wireless networks provide robust security protections. Traffic of a wireless network can be filtered or simply blocked very easily.
- Using wireless networks users are no longer tied to a specific location, as were with a wired connection. With a laptop computer or mobile device, access can be available at different locations.
- In most of the wireless networks users can connect automatically if they are within the range.
- Setting up a wireless network can be much more cost effective than buying and installing cables. Because wireless networks eliminate or reduce wiring costs.
- Adding new computers to a wireless network is very easy. We can easily expand wireless network with existing equipment, while a wired network might require additional wiring.
- Wireless networks provide remote access to the company's key applications and resources, helps employees to get the job done while they are away from the company.

Disadvantages of Wireless Networks

- The main disadvantage of the wireless network is security breach. Intruders (hackers) can tap into a wireless network relatively easier than a wired network.
- Another disadvantage is about its coverage that somewhere users might face problems of range of signals.
- Sometimes wireless networks speed can be slower than wired networks because of the low signals.
- Because wireless networks use radio signals and similar techniques for transmission, they are susceptible to interference from magnetic or electronic effects.
- Wireless signal energy weakens rapidly as the signal passes through the environment consisting of trees, buildings, etc.
- In wireless networks bad weather also plays a role in weakening the signals.

Teacher Point

1. Teacher should explain some advantages of wireless networks.

6.1.3 RADIO SIGNAL

A radio signal or radio wave is an electromagnetic wave propagated by an antenna. Radio waves have different frequencies and tuning a radio receiver to a specific frequency you can pick up a specific radio signal.

All the Radio Frequency (RF) systems consist of two components, a transmitter and a receiver as shown in Fig.6.2. A transmitter transmits a radio signal to a receiver which listens for the signal and receives it. RF systems include a set of rules that define how the transmitter and receiver communicate. For example, a rule set can specify that the transmitter must communicate with the receiver at a specific frequency. Early radio signals were analogue but today most of the radio signals are digital.

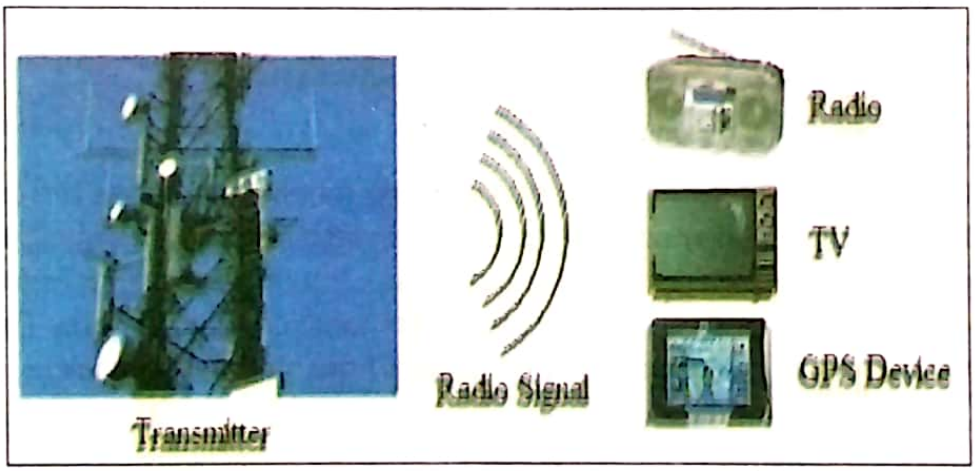


Fig. 6.2 Communication using radio signal

6.1.4 RADIO TRANSCEIVER

A transceiver is a device which can transmit and receive a radio signal and have a common circuitry in a single housing. In case of radio, the transmitter and the receiver are separated. The radio broadcasting station is basically a transmitter and the radio is a receiver. But in many cases, like cell phone, the device serves the both functions. Therefore, a cell phone is a transceiver. A radio transceiver is shown in Fig.6.3.

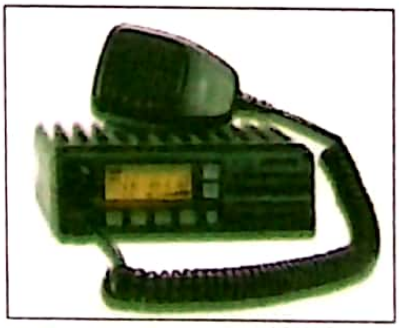


Fig.6.2 Radio Transceiver

6.1.5 WIRELESS ACCESS POINT (WAP)

A Wireless Access Point (WAP) is a device that allows wireless devices to connect to a wired network using Wi-Fi. The access point connects to the wired network and then broadcasts signals wirelessly to all the other wireless devices such as laptop computers as shown in Fig.6.3. For computers to communicate over a wireless network, they must support the wireless LAN protocol called Wi-Fi. Today many computers come fully equipped with integrated Wi-Fi, so they are ready to get connected to the wireless access point.

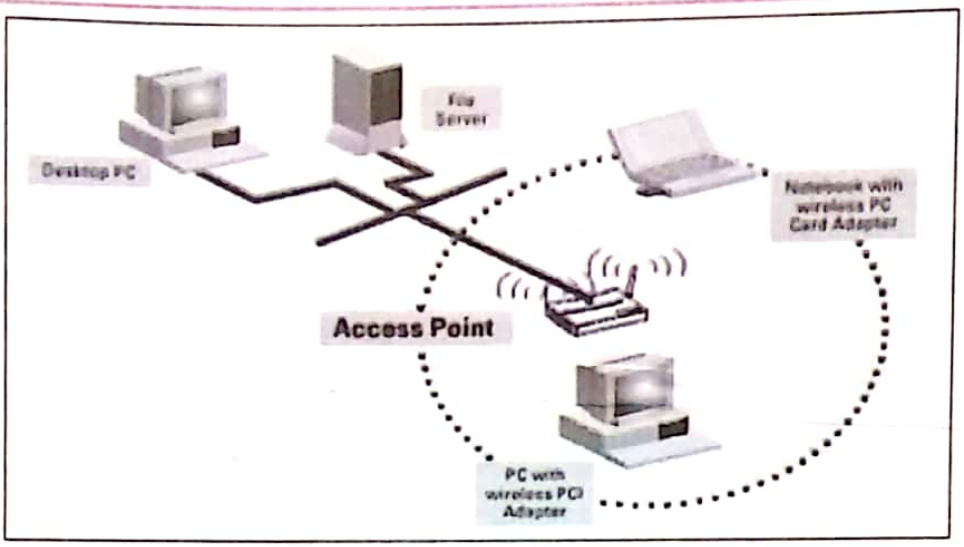


Fig.6.3 Network using Wireless Access Point

6.1.6 LINE OF SIGHT COMMUNICATION

In Line of Sight (LOS) communication, the transmitter and receiver antennas are in line of sight as shown in Fig.6.4. Line of sight communication is used in high frequency communication where the signals cannot pass through structures and hills. For long distance communication, transmitters are installed on high buildings, mountain tops or high towers. Relay stations (boosters) are used to amplify the signals and retransmit from station to station.

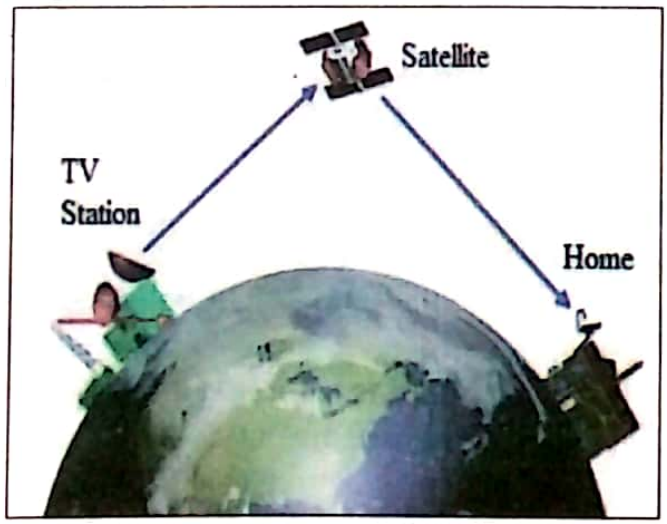


Fig.6.4 Line of Sight Communication

6.1.7 SHORT AND LONG DISTANCE WIRELESS COMMUNICATIONS

Wireless communication may be differentiated based on the region it covers into short distance and long distance wireless communication.

Teacher Point

Teacher should explain the difference between short distance and long distance wireless technologies with examples.

Short Distance Wireless Communication

Short distance wireless communication consists of very short distance of few meters (Infra-red) to a distance of up to 50 Km (Wi-Max). Following are the types of short distance wireless communications.

- Wi-Fi
- Wi-Max
- Bluetooth
- Infra-red

Long Distance Wireless Communication

Long distance wireless communication comprises of distances above 50 Km using either cellular communication methods or Global Positioning Systems which utilizes satellites.

6.2 SHORT DISTANCE WIRELESS COMMUNICATION

6.2.1 Wi-Fi

Wi-Fi (Wireless Fidelity) is a wireless communication system very commonly used at home and office. It is also called WLAN (Wireless LAN). It is a popular wireless networking technology which uses radio waves to provide wireless high-speed Internet and network connections. Wireless networks are easy to setup and are inexpensive. In Wi-Fi, information travels over the air. These networks are extremely limited in range due to low power of transmissions allowing users to connect only within close proximity to a router or signal repeater. Wi-Fi is common in home networking applications which provides portability without any need of cables. Wi-Fi networks need to be secured with passwords for security purposes in order not to be accessed by others.

6.2.2 Wi-Max

Wi-Max (Worldwide Interoperability for Microwave Access) is a wireless network that provides public network service to users. It is very similar to Wi-Fi but covers a big range of 40 to 50 Km. Wi-Max creates a Metropolitan Area Network (MAN) and provides a wireless alternative to Cable TV and DSL Internet connection. It provides service just about anywhere you go within a city. It transmits information through microwave and uses a more complex technology than Wi-Fi.

6.2.3 BLUETOOTH

Bluetooth is a short-range and low speed wireless communication technology. Its range is around 10 meters with the data transfer rate up to 723 Kbps and it consumes low power. It provides a way to connect and exchange information between devices such as mobile phones, laptop computers, PCs, printers, digital cameras, and video game consoles. Bluetooth can be used to replace cables between the PC and the linking devices such as printers, keyboards, mouse, etc.

6.2.4 INFRA-RED

Infra-red (IR) waves are extremely high frequency waves which are used for very short range communication. Some common applications of infrared technology are listed below.

- Car locking systems use Infrared technology for automatic locking and unlocking the doors of cars.
- Modern Computers have infrared enabled mouse, keyboards, and printers.
- Home security systems have infrared enabled burglar alarm system.
- Remote control system in TVs, Toys, etc uses infrared technology.

6.3 LONG DISTANCE WIRELESS COMMUNICATION

Long Distance wireless communication systems provide services that are not possible with the use of cables. It includes cellular and global positioning systems.

6.3.1 CELLULAR COMMUNICATION

Cellular communication refers to wireless communication systems that divide a geographical region into sections called cells. Each cell has a Base Station (BS) at the center that contains a transceiver and controller that provides radio communication to mobile phones.

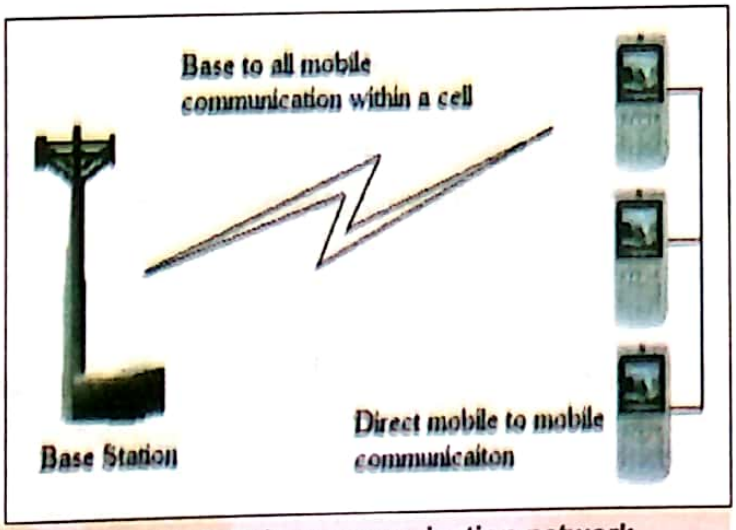


Fig.6.5 Cellular communication network

In cellular communication, each mobile phone uses a separate temporary radio frequency (channel) to talk to the Base Station (BS). The BS talks to many mobile users at the same time as shown in Fig.6.5. Channels use a pair of frequencies for communication. One frequency, the uplink is used for the mobile phone to communicate with the BS and another frequency for the down link for BS to communicate with the mobile phone. The basic concept of cellular communication is that it reuses the radio frequency by the cell that are at a distance where there is no interference of the other.

6.3.2 GLOBAL POSITIONING SYSTEM

Global Positioning System (GPS) is a radio navigation system that allows people on land, in sea or in the air to determine their exact position, 24 hours a day anywhere in the world in all weather conditions.

In the modern era of communication, satellites are widely used. A satellite is a relay station which is placed into orbit by human. They are sometimes called artificial satellites to distinguish them from natural satellites such as the moon. Satellites are used for various purposes such as military and civilian earth observation satellites, communications satellites,

navigation satellites, weather satellites, and research satellites. The orbits used by the satellites may be defined as Geostationary Earth Orbit, Medium Earth Orbit and Low Earth Orbit.

GPS are used for navigation, on airplanes, ships, ground vehicles, and by individuals. Also the relative positioning and time data is used to study the movement of tectonic plates to understand the earthquakes, astronomical observations, telecommunications, etc. Global positioning system is shown in Fig.6.6.

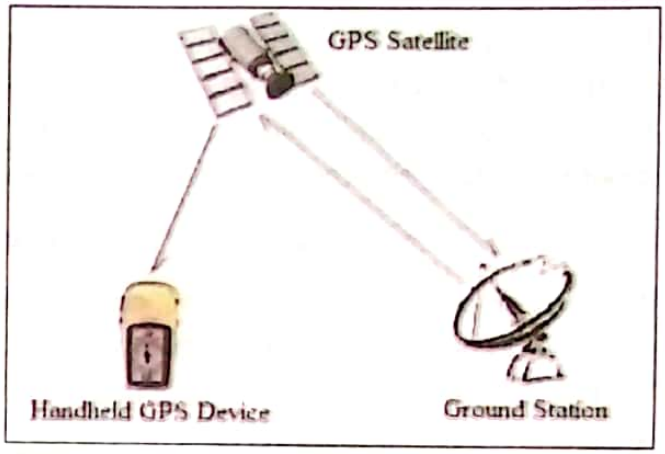


Fig.6.6 Global Positioning System

6.3.3 CLASSIFICATION OF SATELLITE SYSTEMS

Satellite Systems can be classified based upon their orbits into the following three types.

- Geostationary Earth Orbit (GEO)
- Medium Earth Orbit (MEO)
- Low Earth Orbit (LEO)

Geostationary Earth Orbit (GEO)

A Geostationary Earth Orbit (GEO) or Geostationary Orbit is an orbit directly above the earth's equator (at 0° latitude), with a period equal to the earth's rotational period. An object in a geostationary orbit appears to be fixed in the sky if observed from the earth. Communications satellites and weather satellites are generally placed in geostationary orbits, so that the satellite earth antennas (placed on earth) that communicate with them do not have to track them, but can be placed permanently at the fix position where they stay.

Medium Earth Orbit (MEO)

A Medium Earth Orbit (MEO) is located above low earth orbit (altitude of 2,000 kilo meters) and below geostationary earth orbit (altitude of 35,786 kilo meters). The satellites placed in this orbit are generally used for navigation, such as the Global Positioning System at an altitude of 20,200 km. For example GLONASS (a Russian satellite-based navigation system) is at an altitude of 19,100 Km and GALILEO (a European Union (EU) satellite-based navigation system) is at an altitude of 23,222 Km from the earth.

Low Earth Orbit (LEO)

A low Earth Orbit (LEO), also known as low orbit, is generally defined from the earth's surface up to an altitude of 2,000 km. But the commonly used definition for LEO is from 160 km

Teacher Point

Teacher may also use presentations or animations or videos for explanation.

to 2,000 km above the earth surface. Less energy is required to place a satellite into a low earth orbit and it requires low power amplifiers for communication. Therefore this orbit is used for many communication applications. Most of the satellites, like the International Space Station, the Space Shuttle, and the Hubble Space Telescope are all exist in Low Earth Orbit.

6.4 MOBILE DEVICE COMMUNICATION

Mobile communication involves the use of mobile devices such as mobile phones, smart phones, PDAs and laptop and tablet computers. Mobile communication devices give the freedom to communicate with others or access information everywhere. These devices improve our efficiency and productivity.

6.4.1 REQUIREMENTS OF MOBILE COMMUNICATION

Communication between mobile phones is established by connecting to a cellular network as shown in Fig.6.7.

The following are the components required for mobile communications.

- Mobile phone or Any Mobile communication device
- Base station
- Switching node
- Landline telephone network

Mobile phone is a device that allows us to make and receive calls over a cellular network. Modern mobile phones also support services such as text messaging, MMS, email and Internet.

Base station communicates with many mobile phones at the same time. It is equipped with a transceiver and antenna for transmitting and receiving signals from mobile phones. It is responsible for handling traffic and signalling between mobile phones.

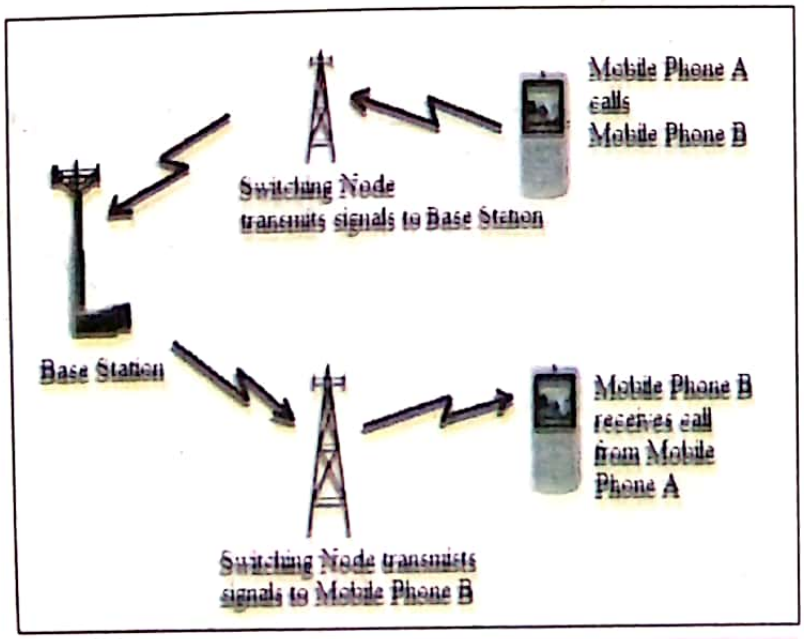


Fig.6.7 Mobile Phone Network

Switching node is a component of cellular network that carries out switching and mobility management functions for mobile phones on network of base station. Switching nodes are owned and deployed by mobile phone operators and allow mobile phones to communicate with each other and telephone landline network.

Telephone Landline Network is a wired Public Switched Telephone Network (PSTN) that is connected with cellular network to provide communication between mobile phone and telephone on PSTN.

6.4.2 ARCHITECTURE FOR COMMUNICATION OVER MOBILE DEVICES

The Mobile Device Communication Architecture includes the following wireless data communication capabilities.

- Web Protocol Stack
- Wireless Markup Language (WML)
- Wireless Application Protocol (WAP)

Web Protocol Stack (HTTP/TCP/IP)

Web Protocol Stack consists of TCP/IP and HTTP. Its purpose is to allow two computers to communicate with each other over the Internet.

When a message is sent over Internet, it is translated from text form to electronic signals at the source computer and then translated back to text form at the destination computer. Every computer needs protocol stack to communicate over the Internet and it is usually built in the operating system such as Windows. The protocol stack used for the Internet is known as TCP/IP protocol stack. Fig. 6.8 shows how message is sent over Internet from source to destination computer over Internet.

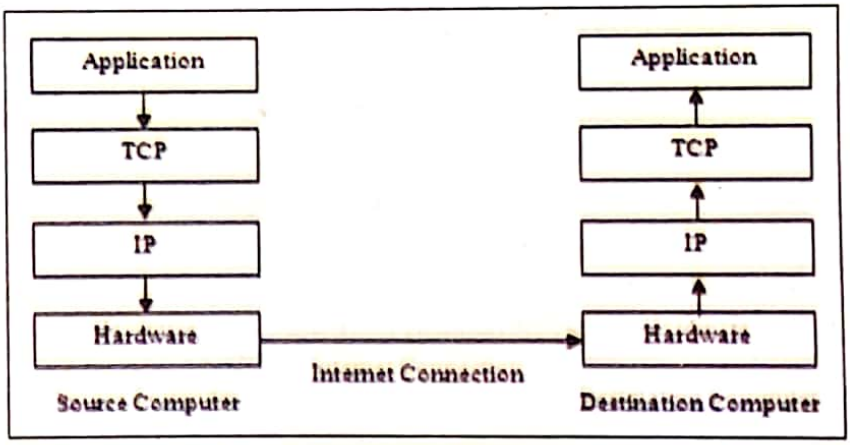


Fig.6.8 Working of Web Protocol Stack

Wireless Markup Language (WML)

Wireless Markup Language is based on HTML and XML and it delivers Internet contents to small wireless devices, such as browser-equipped mobile phones and other handheld devices. These devices have very small displays, slow CPUs, limited memory capacity, low bandwidth and restricted user-input capabilities. WML demands less memory and processing power from browsers than HTML. WML also includes features that support relatively small display sizes of today's wireless devices.

Wireless Application Protocol (WAP)

WAP consists of multiple protocols that provides Internet access to mobile users of wireless phones and other wireless devices such as pagers and personal digital assistants

Teacher Point

- GPS should be demonstrated through videos available on Internet (youtube.com).
- Teacher should give some home assignments to the students at the end of the chapter.

(PDAs). Today, it has become the standard for providing data and voice services to wireless hand-held devices.

6.4.3 LIMITATIONS OF MOBILE COMMUNICATION SYSTEMS

Following are some limitations of mobile communication system.

- Without proper protection, hackers can install spyware on other's mobile devices for capturing credit card information, account login details and password which can be very harmful.
- Wireless mobile communication has the limitation of low processing capability, high error rate and low storage availability.
- Handheld mobile devices have the limitations of small display, low memory, limited battery power and limited CPU power.
- Mobile devices readily access information from the World Wide Web. The validity and accuracy of information cannot be guaranteed since anybody can easily upload any information on Web sites unlike books that undergo a process of scrutiny before publication.
- Mobile Internet users copy and paste information from Web sites without the permission of publisher and this is violations of property rights.
- Daily use of mobile computing devices will eventually make people more dependent on them instead of relying on their own potentials.

Key Points

- Wireless communication technologies receive and transmit information using electromagnetic waves.
- A Transceiver is a device which can transmit and receive a radio signal and has a common circuitry in a single housing.
- A Wireless Access Point (WAP) is a device that allows wireless devices to connect to a wired network using Wi-Fi.
- In Line of Sight Communication, the transmitter and receiver antennas are in line of sight and it uses high frequency communication where the signals cannot pass through structures and hills.
- Short distance wireless communication consists of very short distance of few meters to a distance of up to 50 Km. Wi-Fi, Wi-Max, Bluetooth and Infrared are the types of short distance wireless communications.
- Long distance wireless communication comprises of distance above 50 Km. using either cellular communication or global positioning system.
- Wi-Fi is Wireless Local Area Network (WLAN).

- Wi-Max wireless network has a range of 40 to 50 Km. It provides wireless alternative to Cable TV and DSL.
- Bluetooth provides a short-range wireless connection to exchange information between devices such as mobile phones, laptops, printers and digital cameras.
- Infra-Red waves are extremely high frequency waves used by remote controls for television, VCR and other similar devices.
- Cellular communication divides a geographical region into sections called cells and has a Base Station (BS) at the center. The BS contains a transceiver and controller that provides radio communication to mobile phones.
- Global Positioning System (GPS) is a radio navigation system that allows people on land, in sea or in the air to determine their exact position.
- Geostationary Earth Orbit is an orbit directly above the earth's equator with a period equal to the earth's rotational period.
- Medium Earth Orbit is located above low earth orbit and below geostationary earth orbit. It is generally used for navigation.
- Low Earth Orbit is located up to an altitude of 2,000 Km from the earth's surface. Less energy is required to place a satellite into a low earth orbit and it requires low power amplifiers for communication.
- Wireless Markup Language (WML) is a markup language used to deliver Internet contents to small wireless devices such as mobile phones and other hand-held devices.

Exercise

Q1. Select the best answer for the following MCQs.

i. Which of the following has a range of 40 to 50 Km?

A. Wi-Fi
B. Wi-Max
C. Bluetooth
D. Infrared

ii. Which of these uses extremely high frequency waves for short range communications?

A. Wi-Fi
B. Wi-Max
C. Bluetooth
D. Infra-red

iii. Which of these is used for communication between mobile phones, laptop computers and digital cameras?

A. Wi-Fi
B. Wi-Max
C. Bluetooth
D. Radio Signal

iv. Which of the these is positioned from 160 to 2,000 Km above the earth surface?

A. Geostationary Earth Orbit
B. Medium Earth Orbit
C. Low Earth Orbit
D. GALILEO

v. Which orbit is located directly above the earth's equator?

A. Geostationary Earth Orbit
B. Medium Earth Orbit
C. Low Earth Orbit
D. GALILEO

vi. What is a fixed station in a cellular wireless network called that provides local coverage for mobile communication?

A. Base station
B. Satellite
C. Mobile Terminal
D. Global Positioning System

vii. What is used to create web pages?

A. HTML
B. HTTP
C. WAP
D. TCP

viii. What is HTTP?

A. Markup language
B. Protocol for mobile phones
C. Application layer protocol
D. Transport layer protocol

ix. Which of these provides wireless alternative to cable TV and DSL?

A. Bluetooth
B. Infra-red
C. Wi-Max
D. Wireless Access Point

x. In which earth orbit satellite is placed for navigation?

A. Geostationary earth orbit
B. Medium earth orbit
C. Low earth orbit
D. High earth orbit

Q2. Give short answers of the following questions.

i. Define radio signal and transceiver.
ii. What is Wireless Access Point?
iii. What is meant by line of sight communication?
iv. Differentiate between short distance and long distance wireless communication.
v. What is base station?
vi. Define Global Positioning System (GPS)?
vii. What is Wireless Markup Language?

viii. What is Wireless Application Protocol?

ix. What is web protocol stack?

x. What is HTTP?

Q3. Give long answers of the following questions.

i. Define wireless communication and mention its advantages and disadvantages.

ii. Describe the following short distance communications.

- Wi-Fi
- Wi-Max
- Bluetooth
- Infra-red

iii. Describe cellular communication and mention its advantages and disadvantages.

iv. Describe GEO, MEO and LEO.

v. Explain how mobile communication is achieved?

vi. What are the limitations of mobile communication?

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. A Wireless Local Area Network (WLAN) should be created to demonstrate wireless communication.
2. Sharing of files/folders on WLAN should be demonstrated.
3. Use of Bluetooth for communication between a mobile and computer should be demonstrated.
4. GPS installed in a Car may be demonstrated to the students through video/animation.

7

DATABASE FUNDAMENTALS

After completing this lesson, you will be able to:

- Differentiate between data and information
- Define file management system
- Define Database and Database Management System (DBMS)
- Identify advantages of DBMS over the file management system
- Identify the role of Database Administrator (DBA)
- Know the types of database models
- Know the types of database languages for relational databases
- Define the basic database terminologies
- Know how to plan a database
- Describe data modeling and draw Entity-Relationship (E-R) diagram
- Transform the E-R diagram to the Relational Schema
- Normalize relations up to third normal form

Reading

UNIT INTRODUCTION

A database is a collection of related files that are usually integrated, linked or cross-referenced to one another. This unit is dedicated to database and database management systems. It introduces the types of database models and provides the basic knowledge about data modelling and E-R diagram for planning and development of a database system. It presents the advantages of using a database management system over the old file management system. It describes the responsibilities of database administrator for the performance, integrity and security of a database.

Teacher Point

Before starting the chapter, the students could be encouraged to explain what they understand about the Database.

7.1 INTRODUCTION TO DATABASE

Databases and database systems have become an essential part of everyday life in modern society. Most of us encounter several activities that involve some interaction with a database. For example, if we go to the bank to deposit or withdraw money; if we make a hotel or airline reservation or if we access a computerized library catalogue to search for a book, chances are that our activities will involve someone accessing a database. Even purchasing items from a supermarket nowadays in many cases involves an automatic update of the database that keeps the inventory of supermarket items.

7.1.1 DATA AND INFORMATION

Data

Data refers to the facts and figures in raw form i.e. not in organized form. Data is the raw material given as input to the computer for processing. For example, the item code, description, quantity and price of items purchased in a store are data. When this data is entered into the computer and processed, it prints the bill which is the output of the computer, also called information.

Information

Information is the processed or organised form of data. When data is processed by the computer and it is properly arranged and organized, it is converted to information. It is also called the output of computer and is the meaningful form of data. For example, the names of students and their marks in all the subjects is data. When it is processed by the computer, the result sheets and report cards produced is information.

7.1.2 FILE MANAGEMENT SYSTEM

A file (or file based) management system is a collection of programs used for managing data stored in various files. Each program within a file management system is developed independently and it defines and manages its own data. In file management system records in one file are not related to the records in any other file. This approach leads to many problems which include data duplication in different files, data inconsistency, sharing of data and lack of flexibility in organizing and querying the data.

For example, a company may store a salesman's name, address telephone number and commission rate in a file in Accounts Department and the same information may be stored in another file in Sales Department. The Accounts Department, for example, may change the commission rate of salesman but the Sales Department may fail to update its file. This will produce reports calculated with out-of-data figures. The inconsistency in files occurred due to duplication of same data in files. This is the main problem faced in file management systems.

Teacher Point

Teacher should explain the advantages and uses of database.

7.1.3 DATABASE APPROACH

In order to solve the problems of traditional file management system for managing data, the concept of a database approach was introduced. A ***database*** is a collection of related data. For example, consider the names, telephone numbers and addresses of the people you know. You may have recorded this data in an indexed address book or you stored it on your computer's hard disk using software such as Microsoft Access or Excel. This is a collection of data having implicit meaning and hence is a database.

A database can be of any size and complexity. For example, a database containing names and telephone numbers of your friends may have only a few records. On the other hand, a database containing information about all the citizens of a country for National Identity Card (NIC) may contain millions of record.

A database may be created and maintained manually or it may be computerized. The library card catalogue is an example of a manually created and maintained database. A computerized database is created and maintained by a database management system, for example Library management system, Stock control system, Examination control system, etc.

7.1.4 DATABASE MANAGEMENT SYSTEM (DBMS)

A database management system (DBMS) is a set of programs that allow users to create, maintain and manipulate database, and store or retrieve data from those database files. It provides user-friendly access and controls between user and database. Its main purpose is to improve data sharing, data access, decision making and increase end user productivity.

Manipulation of data includes the following.

- Adding new data, for example adding details of new student.
- Deleting unwanted data, for example deleting the details of students who have completed course.
- Changing existing data, for example modifying the fee paid by the student.

The DBMS helps to create an environment in which users have better access to data. DBMS helps to give an integrated view of the organization's operations. The DBMS makes it possible to share the data in the database among multiple applications and users.

Some examples of the database systems managed by DBMS are:

- Customer information system
- Inventory information
- Library management
- Accounting and bookkeeping

Examples of DBMS include Microsoft Access, Microsoft SQL Server, Sybase, Oracle, MySQL, etc.

7.1.5 ADVANTAGES OF DBMS OVER CONVENTIONAL FILE MANAGEMENT SYSTEM

DBMS has many advantages over conventional file management system. These are:

Reduced Data Redundancy: Data redundancy is the duplication of data in many different files in file management system. For example, a salesman's data may be held on a file in the Sales Department and also Personnel Department. When data is to be updated, it must be changed in both files. This results in wastage of storage space and may lead to data inconsistency.

This problem is not faced in DBMS because all the data belonging to the entire organization is centralized in a common pool of data, accessible by all the programs.

Data consistency: In file management system, same data may be held in several different files, it has to be updated in each separate file when it changes. If data is not updated in any file it causes data inconsistency.

This problem is solved in DBMS because all the data is centralized for use by all the programs. For example, in a school, students' information such as name, address, phone number and class are held in a file in Admission Office. The same data with tuition fee and some other data is also kept in another file in Accounts Office. If a student's address changes it must be updated on both files. In case it is updated in only one file, the other file will have out-of-date data. This will cause data inconsistency.

No Program-Data Dependency: In file management system, every computer program in each department has to specify exactly what data fields constitute a record. Any change to the format of the data field of a record, such as adding a new field or changing the length of a field means that every program which uses that file has to be changed. For example, if a new field, place of birth of students is to be added in student data files in Admission Office and Accounts Office, then both the programs need to be changed. In DBMS as data is not program dependent so such problems do not arise.

Flexibility: In file management system, when information of a non-routine nature is needed, it can take weeks to assemble the data from the various files and write new programs to produce the required reports. For example, a report about students is required in a school that has to merge information stored in various files. This will require lot of time and effort by the programmer to write a program to print such a report in file management system whereas it can be very easily produced in database management system.

Data Sharable: When a copy of a data file is made for sharing data with other people in a file management system, it will soon lead to data inconsistency if data in one of the files is not updated. Therefore, it is difficult to share data with others in a file management system. But in DBMS data can be shared very easily.

Backup and Recovery: DBMS provides facilities for backup and recovery from failures including disk crash, power failure, software errors, which may bring the database from the inconsistent state to a state prior to the failure. This feature is lacking in file management system.

Data Security: In Conventional filing systems there is no centralized security system which restricts users according to their role in the organization. DBMS makes it easier to enforce security restrictions since database is centralized. Users are provided permissions to access data according to their rights.

7.1.6 ROLE OF DATABASE ADMINISTRATOR (DBA)

Database Administrator (DBA) is the person responsible for supervising the database and the use of DBMS in an organization. DBA has the following responsibilities.

- Designing the database and enforcing the operational policies and procedures for its usage
- Planning security measures and backup of database
- Controlling privileges and permissions of database users
- Allocating passwords to users
- Planning recovery procedures if hardware or software failure occurs and ensuring that no data is lost.
- Providing training to new employees about using the database

7.1.7 DATABASE MODELS

A database model is the theoretical foundation of a database and determines in which manner data can be stored, organized and manipulated. It defines a way of structuring data. There are five types of database models.

Hierarchical Database Model

In a hierarchical model, data is organized into a tree-like structure as shown in Fig.7.1. It is a logical construct with owner and subordinate relationship. Data elements in a subordinate relationship are called members and those having subordinates are called owners. In a hierarchical structure subordinates can have only a single owner and there is only one data element that has no owner. This structure is very suitable in describing many relationships in the real world. Some examples of hierarchical model are table of contents, departments of an organization and types of memories.

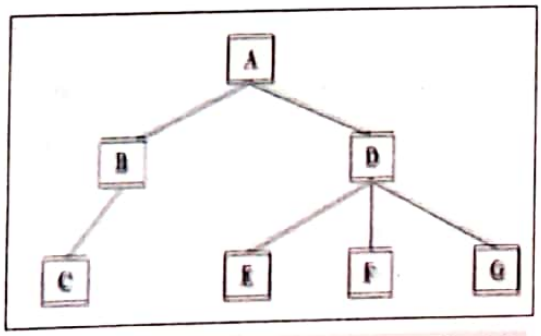


Fig. 7.1 Hierarchical Database Model

Network Database Model

A network model is a logical structure in which some of the data elements can have more than one owner data element as shown in Fig.7.2. A network is a more complex structure than a hierarchical model. A hierarchical model can be thought of as a network with some discipline imposed on it. An application with which crew members, aircraft, routes and schedules are related is by its nature a network model.

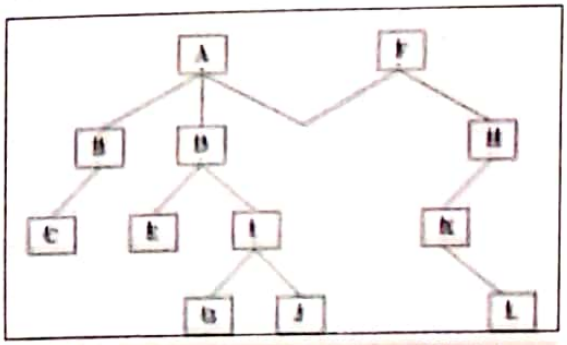


Fig. 7.2 Network Database Model

Relational Database Model

In a relational database model, data is held in tables as shown in Fig.7.3 and the tables are linked by means of common fields. The "relation" in a relational database refers to the various tables in the database which are linked with each other. A table in database consists of rows and columns. One row of table holds one record. Each column in the table holds one field or attribute.

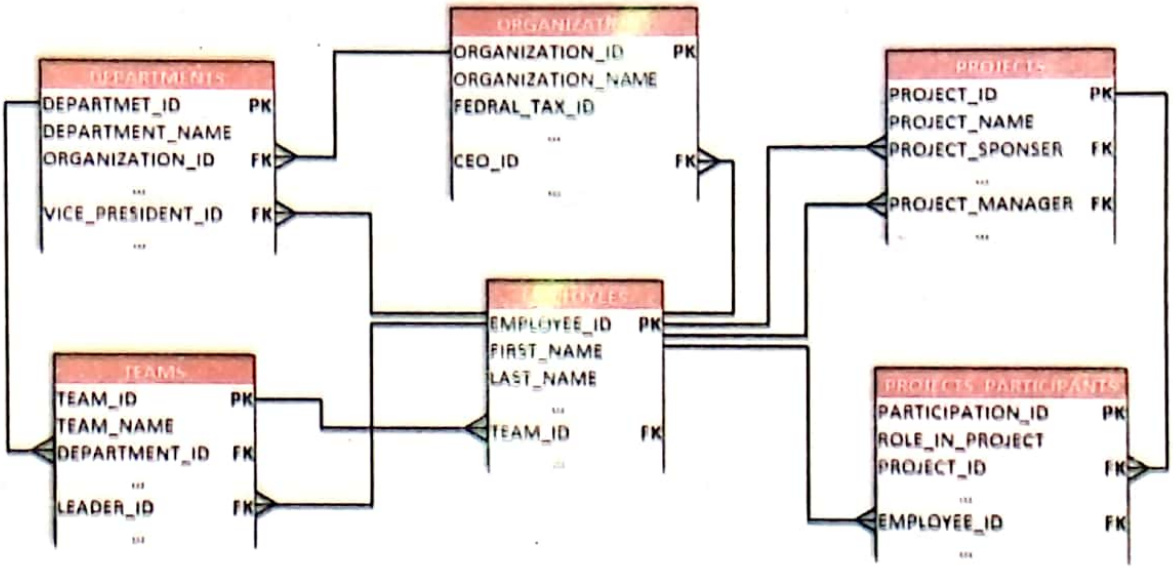


Fig.7.3 Table in a relational database

The relational database model is used to make database management systems more independent of any particular application. It is the most popular database model used in business applications.

Object-Oriented Database Model

Object-oriented databases are also called Object Database Management Systems (ODBMS). Object databases store objects rather than data such as integers, real numbers and strings. Objects are used in object oriented programming languages such as C++ and Java.

Object: Radio	
States	Behaviours
on	turn on
off	turn off
current channel	tune channel
volume	increase/decrease volume

Fig.7.4 States and Behaviour of object Radio

Real world objects have two characteristics, that is, state and behaviour. For example, the object radio has four states and five behaviours as shown in Fig.7.4. An object stores its states in variables and exposes its behaviour through functions in programming languages.

Object Relational Database Model

An Object Relational Database (ORD) is a database management system similar to relational database, but with an object-oriented database. In object relational database, the approach is essentially that of relational database. The data resides in the database and is manipulated collectively with queries in a query language.

7.1.8 DATABASE LANGUAGES

SQL (Structured Query Language) is a standard language for accessing and manipulating databases. There are three types of SQL languages for relational databases. These are:

- Data Definition Language
- Data Manipulation Language
- Data Control Language

Data Definition Language

Data Definition Language (DDL) is a computer language for defining different data structures. DDL statements create, modify and remove data objects such as tables. Some important tasks of DDL are:

- To create objects in a database model
- To alter the structure of the database
- To delete objects from the database

Data Manipulation Language

Data Manipulation Language (DML) statements are used to manage or manipulate data. Some examples of DML tasks are:

- To retrieve data from a database
- To insert data into a table
- To update existing data within a table
- To delete records from a table

Data Control Language

Data Control Language (DCL) is used for controlling the data. A user can access the data based on the privileges given to him. Some important tasks of DCL are:

- To allow specified users to perform specific tasks
- To disallow specified users from performing specified tasks
- To cancel previously granted or denied permissions

7.2 DATABASE TERMINOLOGIES

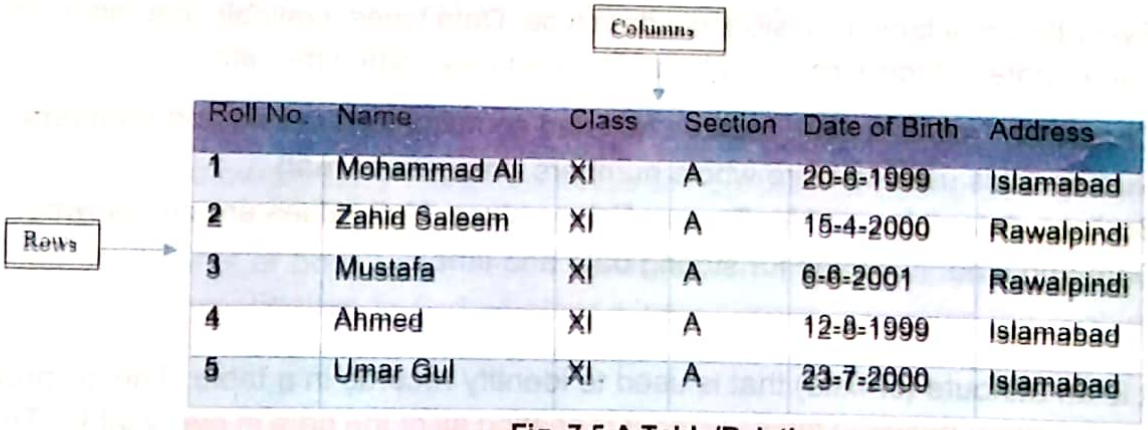
An effective DBMS provides users with timely, accurate and relevant information. This information is stored in computer files, which needs to be suitably organized and properly maintained so that users can easily access the information they need.

The following are some important terms used in database.

Table/Relation

A database **Table** or **Relation** is a file that contains data about a single entity. Any object or thing about which data is going to be stored in a database is called an **Entity**. An entity can be a person, place or event, etc. For example 'Student', 'Teacher', 'Stock', etc. are entities. A database table is composed of rows and columns. Rows hold the records and columns hold the fields. Data item is inserted at each row and column intersection. Tables are also called relations in RDBMS.

Each table in a database holds data about a different but related subject. Fig. 7.5 shows a database table containing data about the entity 'Student'.



Roll No.	Name	Class	Section	Date of Birth	Address
1	Mohammad Ali	XI	A	20-6-1999	Islamabad
2	Zahid Saleem	XI	A	15-4-2000	Rawalpindi
3	Mustafa	XI	A	6-6-2001	Rawalpindi
4	Ahmed	XI	A	12-8-1999	Islamabad
5	Umar Gul	XI	A	23-7-2000	Islamabad

Fig. 7.5 A Table/Relation

Record/Tuple/Row

A collection of related fields treated as a single unit is called a record. All the information about one person or item is held in a record. When records are stored in a table, rows represent records and columns represent fields. In relational database rows are also known as tuples. Database table in Fig. 7.5 has five records, represented row wise, about the entity 'Student'.

Fields/Attribute/Column

A field or attribute is part of a record and contains a single piece of data for the subject of the record. In the database table illustrated in Fig.7.5, each record contains six fields:

Roll No.	Used to assign a unique roll number to a student.
Name	Used to give name of the student
Class	Used to give class of the student

Section	Used to store the section of the student
Date of Birth	Used to give date of birth of the student
Address	Used to give the address of the student

Fields appear as columns in a database table.

File

A file is a collection of records. For example a stock file contains records for items of stock, a payroll file contains records for employees and so on. In a relational database records are stored in files called tables/relations. Fig. 7.5 shows a table/relation of 'Student' file.

View

It is made up of rows and columns. It may display information that is restricted to a part of table. It may also present selected data from several tables simultaneously. View cannot exist independently of tables.

Data Types

Every field in a table is assigned a data type. Data types available in a relational database are character data, integers/real numbers, Boolean data, date/time, etc.

- Character/Text: It is used to store text and combinations of text and numbers
- Number: It is used to store whole numbers (Integers or real).
- Boolean data: It is used for True or False values. Null values are not allowed.
- Date and time: It is used for storing date and time.

Key

It is an attribute (or field) that is used to identify records in a table. The purpose of key is to link data together between tables without repeating all of the data in every table. The following are the types of keys used in databases.

Primary Key: Each entity in a database must have a unique key field known as primary key to identify a record. For example, Roll Number of a student can be used as primary key in a student database (Fig. 7.5) since it is unique key field.

Candidate or Alternate Key: A key field that can act as a primary key field in a table to uniquely identify each record but it is not chosen as primary key is known as candidate or alternate key. For example, Roll Number of a student is chosen as primary key field in a student database. N.I.C. Number of a student is unique and it can also act as primary key. Therefore, N.I.C Number is a candidate or alternate key.

Teacher Point

Teacher should explain the advantages of DBMS over the file management system.

Secondary Key: Sometimes a records in a table need to be searched on field other than primary key such a field is known as secondary key. For example, a student table needs to be search by name. Then name becomes secondary key.

Foreign Key: A key field used in a relationship between tables whose value matches a primary key in the other table is known as foreign key. Suppose a student database has two tables a Student table that contains students' particulars and another Result table that contains their results. Student table is the primary table in which Roll Number is primary key. To link the student table and the Result table, the field Roll Number can also be used as foreign key in the Result table.

7.3 PLANNING A DATABASE

Database planning is a systematic approach to the development of database that moves from concept to design and development to implementation. A well-designed database promotes consistent data entry and retrieval. Database should be planned in a systematic way to save time, efforts and make it perform the expected tasks. The time and work required to plan a database depends on its complexity.

The following steps are involved in planning a database.

Problem Identification/Definition

In this step the nature and scope of the problem, to be solved, is identified and the problem is clearly defined. The database developers must know what type of information is given and what are the unknowns. They have to analyse the problem to gather as much information as possible for finding a solution. For example, the Examination Section Head of a College has been getting complaints of poor Examination services from the Examination department. This may lead an initial investigation to find whether a new system can solve the problem. If the report suggests a new system, this leads to the next phase which is the feasibility study of the new system.

Feasibility Study

The purpose of feasibility study is to find one or more solutions of the problem and to suggest the most desirable and economical solution. For this purpose the database developer needs to generate several solutions of the problem to accomplish the desired task and propose one solution. Feasibility study includes the following.

- Investigate the problem
- Find out all the possible solutions available
- Study all the solutions to determine their feasibility (e.g. Economic feasibility)
- List the issues with each solution
- Select the preferred solution for implementation
- Document the results in a feasibility report

Teacher Point

Database planning stages to be explained with some suitable example.

Requirement Analysis

The purpose of requirement analysis is to obtain thorough and detailed understanding of the problem. It is important to create a complete and accurate representation of all the requirements. Only then, it is possible to develop a database that fully satisfies the requirements.

For example, to develop 'College Examination System' a detailed study is needed to analyse the requirements. This will include the following:

- Entities required i.e. the number of tables (database files) required (like Student, Exam, Exam Type, Result, Courses, etc.)
- Fields required for each entity in each table (like Roll No., Name, Class, Section, etc. for Student entity)
- Key field in each table (E.g. R.No. in Student file)
- Data types to attributes/fields (E.g. 'number' to R.No. field)
- Relationship between entities
- Queries
- Forms design
- Reports

Identify Entities and Attributes

After requirements identification, the next step is to identify the entities and its attributes. An entity is the main data object that is of significant interest to the organization. It is usually a person, place, thing, or event to be recorded in the database.

An Attribute is a property that describes an entity. For example if employee is an entity then, the employee's name, age, address, salary and job etc. are the attributes

For example, to develop 'College Examination System' the following entities and attributes will be required as shown in Fig. 7.6.

Entities	Attributes
Student	Roll_number, Name, Class, Section, Date of birth, Address
Course	Course_Id, Course_name, Description
Exam	Exam_Id, Exam_name, Start_date
Exam_result	Marks

Fig. 7.6 Entities and Attributes of Examination System

Assigning Names to Tables and Columns/Attributes

Once entities and attributes are identified, entities are converted to tables and attributes to columns of the tables. There are no standard conventions for naming tables and columns but

all names should be meaningful and consistent throughout the database. For example "Student" for Student's table. In case of attributes, meaningful names should be used wherever possible.

For example, the College Exam System may have the table name 'Student' and the columns (attributes) may be assigned the names, Roll number, Name, Class, Section, Date of birth, Address. The table Student is shown in Fig.7.7 with three records.

Roll_number	Name	Class	Section	Date of birth	Address
1	Ali	XI	B	23/5/2000	Islamabad
2	Gohar	XI	B	01/6/1999	Rawalpindi
3	Mustafa	XI	B	12/7/2001	Islamabad

Fig.7.7 Table Student with three records

Assigning datatypes to the attributes

Once attributes are decided, each attribute is assigned a relevant datatype. For example 'Roll_number' is assigned a datatype 'number' in Student file.

7.4 DATA MODELING AND ENTITY-RELATIONSHIP DIAGRAM

7.4.1 DATA MODELING

Data modeling is the process of designing logical structure of a database with a diagram using text and symbols to represent the way data needs to flow. This diagram is called Entity-Relationship diagram (ERD). Data models define how data is connected to each other and how they are processed and stored inside the system. Data models are built during the analysis and design phases of a project to ensure that the requirements for a new application are fully understood. A data model can be thought of as a diagram or flowchart that illustrates the relationships between data. Well-documented conceptual, logical and physical data models allow stake-holders to identify errors and make changes before any programming code has been written.

Data model designers often use multiple models to view the same data and ensure that all processes, entities, relationships and data flows have been identified. There are several different approaches to data modeling, including:

Conceptual Data Modeling - identifies the highest-level relationships between different entities.

Enterprise Data Modeling - similar to conceptual data modeling, but addresses the unique requirements of a specific business.

Logical Data Modeling - illustrates the specific entities, attributes and relationships involved in a business function. Serves as the basis for the creation of the physical data model.

Physical Data Modeling - represents an application and database-specific implementation of a logical data model.

When a system developer designs a new database system, one crucial task is to identify and state the data needs of the organization. This describes how the data elements in the system are to be grouped.

The following terms are used in building a picture of the data requirements.

Entity: An entity is a thing of interest to an organization about which data is to be held. Examples of entities include Student, Customer, Employee, Stock Item, Supplier, etc.

Attribute: An attribute is a property or characteristic of an entity. Examples of attributes associated with a Customer include Customer ID, Surname, Initials, Title, Address, etc.

Relationship: A relationship is a link or association between entities. An example is the link between Dentist and Patient; one dentist has many patients, but each patient has only one dentist.

Keys: It is an attribute used to identify a record in a database. Keys are used to create links between tables to avoid duplication of data in various tables.

7.4.2 Entity-Relationship (ER) Diagram

The Entity-Relationship (ER) diagram or model defines the conceptual view of a database. It is made up of entities and the associations among them. At view level, the ER model is considered a good option for designing databases. Any object, for example, entities, attributes of an entity, relationship sets, and attributes of relationship sets, can be represented with the help of an ER diagram. ER Model is best used for the conceptual design of a database.

ER Model is based on:

- **Entities** and their attributes.
- **Relationships** among entities.

These concepts are explained in Fig. 7.8.

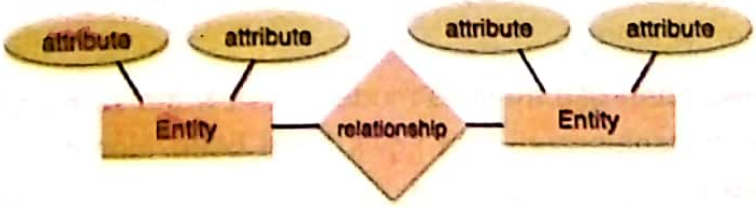


Fig.7.8 ER diagram concept

Entity

An entity in an ER Model is a real-world entity having properties called **attributes**. Every **attribute** is defined by its set of values called **domain**. For example, in a school database, a 'Student' is considered as an entity. Student has various attributes like roll number,

Fig.7.9 Entities

name, age, class, etc. Entities are represented by means of rectangles. Rectangles are named with the entity set they represent. Fig. 7.9 shows some entities.

Attributes

Attributes are the properties of entities. Attributes are represented by means of ellipses. Every ellipse represents one attribute and is directly connected to its entity (rectangle). Fig 7.10 shows three attributes 'Roll_No.', 'Name' and 'BirthDate' of entity 'Student'. The primary key attribute is underlined, for example Roll_No. attribute.

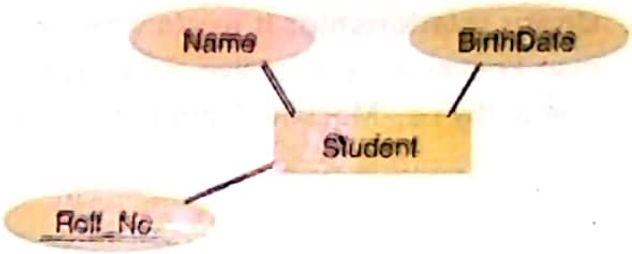


Fig.7.10 Attributes

Relationship

Relationship – The logical association among entities is called **relationship**. Relationships are represented by a diamond symbol connected to the related entities. Fig 7.11 shows some relationships between entities.

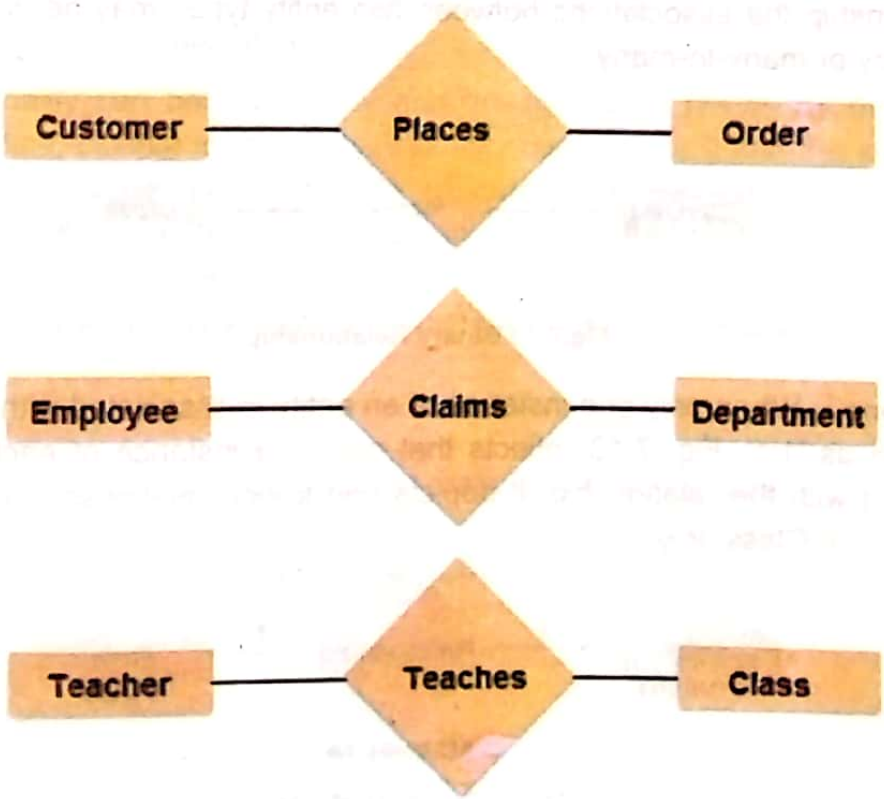


Fig.7.11 Relationships

Teacher Point

1. Teacher should give some home assignments to the students at the end of the chapter.

Degree of a Relationship

The number of participating entities in a relationship is known as the degree of the relationship. It has two types.

i. **Unary relationship:** It exists when an association is maintained within a single entity. It is also known as a recursive relationship. Fig. 7.12 shows a unary relationship, in which only one entity i.e. 'Machine Operator' is maintaining the recursive relationship.

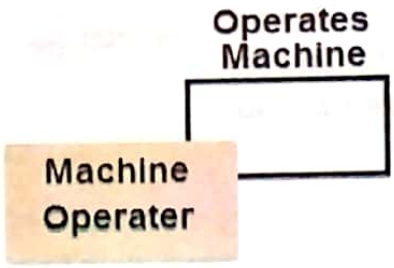


Fig.7.12 Unary Relationship

ii. **Binary relationship:** It exists when two entities are associated with each other through a relationship. OR If there are two entity types involved.

In binary relationship the associations between two entity types may be described as one-to-one, one-to-many or many-to-many.

Fig.7.13 Binary Relationship

- **One-to-one –** When only one instance of an entity is associated with the relationship, it is marked as '1:1'. Fig. 7.13 reflects that only one instance of each entity should be associated with the relationship. It depicts one-to-one relationship as one Student can belong to one Class only.

Fig.7.14 One-to-one Relationship

- **One-to-many** – When more than one instance of an entity is associated with a relationship, it is marked as '1:N'. Fig. 7.14 reflects that only one instance of entity on the left and more than one instance of an entity on the right can be associated with the relationship. It depicts one-to-many relationship as one Student can take many Exams.

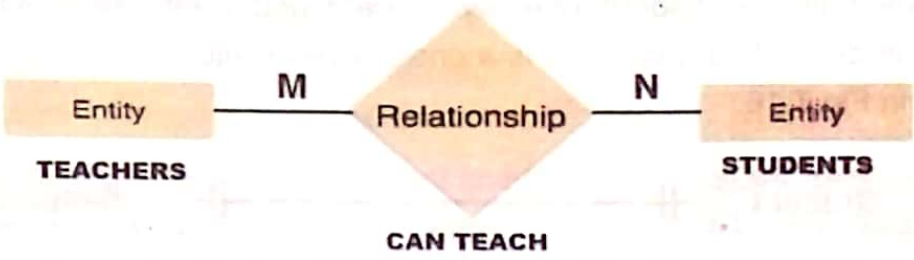


Fig.7.15 Many-to-many Relationship

- **Many-to-many** – When more than one instance of an entity on the left and more than one instance of an entity on the right can be associated with the relationship. Fig. 7.15 shows many-to-many relationship. It depicts many-to-many relationship as many Teachers can teach many Students.

7.4.3 CARDINALITY AND MODALITY

Cardinality and modality specify the business rules in a relationship.

Cardinality refers to the maximum number of times an instance in one entity can be associated with instances in the related entity. An instance in a database is the actual content of the database at a particular point in time.

Modality refers to the minimum number of times an instance in one entity can be associated with an instance in the related entity.

Cardinality can be 1 or many and the symbol is places on the outside ends of the relationship line, closest to the entity. Modality can be 1 or 0 and the symbol is placed on the inside, next to the cardinality symbol. When cardinality and modality are specified together in a relationship between entities, for a cardinality of 1, a straight line is drawn. For a cardinality of many, a foot with three toes is drawn. For a modality of 1 a straight line is drawn and for 0 a circle in drawn. Cardinality and modality are shown at both ends of the relationship line.

Cardinality is many and modality is zero

Cardinality is many and modality is 1

Cardinality is 1 and modality is 1.

Cardinality is 1 and modality is zero.

Example 1: Let us draw E-R diagram of entity 'Student' and 'Seat' that specifies the cardinality and modality. A student fills a seat. This is a one-to-one relationship. This relationship can be drawn as shown in Fig.7.16.

Fig.7.16 Relationship between Student and Seat

Cardinality: One student can fill a maximum of one seat. One seat can be filled by a maximum of one student. Each side of the relationship has a cardinality of one.

Modality: The modality on each side is also one. A student must fill at least one seat, and one seat must be filled by at least one student.

Example 2: Let us see the relationship between the entities 'Teacher' and 'Course'. A teacher teaches one or more courses. This is a one-to-many relationship. This relationship is shown in Fig.7.17.

Cardinality: One teacher can teach many courses. One course is taught by only one teacher. The cardinality is one to many.

Modality: The modality is one on both ends of the relationship. One teacher must teach at least one course and a course must be taught by one teacher.

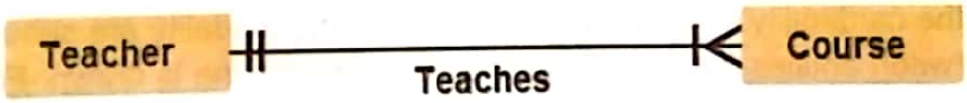


Fig.7.17 Relationship between Teacher and Course

Example 3: A 'Branch' of a company has many 'Departments' and each department is managed by a 'Manager'. The E-R diagram that shows the cardinality and modality for this is shown in Fig.7.8.

There are three entities in this example which are Branch, Department and Manager. Following are the cardinalities and modalities between these entities.

Cardinality between Branch and Department

- Each Branch has one or more departments.
- One Department can only be in one branch.

Therefore, cardinality between Branch and Department is one-to-many as shown in the E-R diagram (Fig. 7.18).

Fig.7.18 Relationship between Branch, Department and Manager

Cardinality between Department and Manager

- Each Department is managed by a Manager.
- Each Manager belongs to only one Department.

Therefore, cardinality between Department and Manager is one-to-one.

Modality between Branch and Department

Modality between Branch and Department is one on both ends of the relationship because each Branch must have at least one Department and each Department belongs to only one Branch.

Modality between Department and Manager

Modality between Department and Manager is also one on both ends of the relationship because a Department must have at least one Manager and a Manager must manage one department.

7.4.4 ENTITY- RELATIONSHIP (ER) DIAGRAM - Examples

The following are few examples of E-R Diagrams for some systems like Library Management System, Student Management System and Ticket Booking System

Library Management System

Library Management Systems consists of three entities. The entities are Books, Readers and Staff. E-R diagram for Library Management System is shown in Fig.7.19.

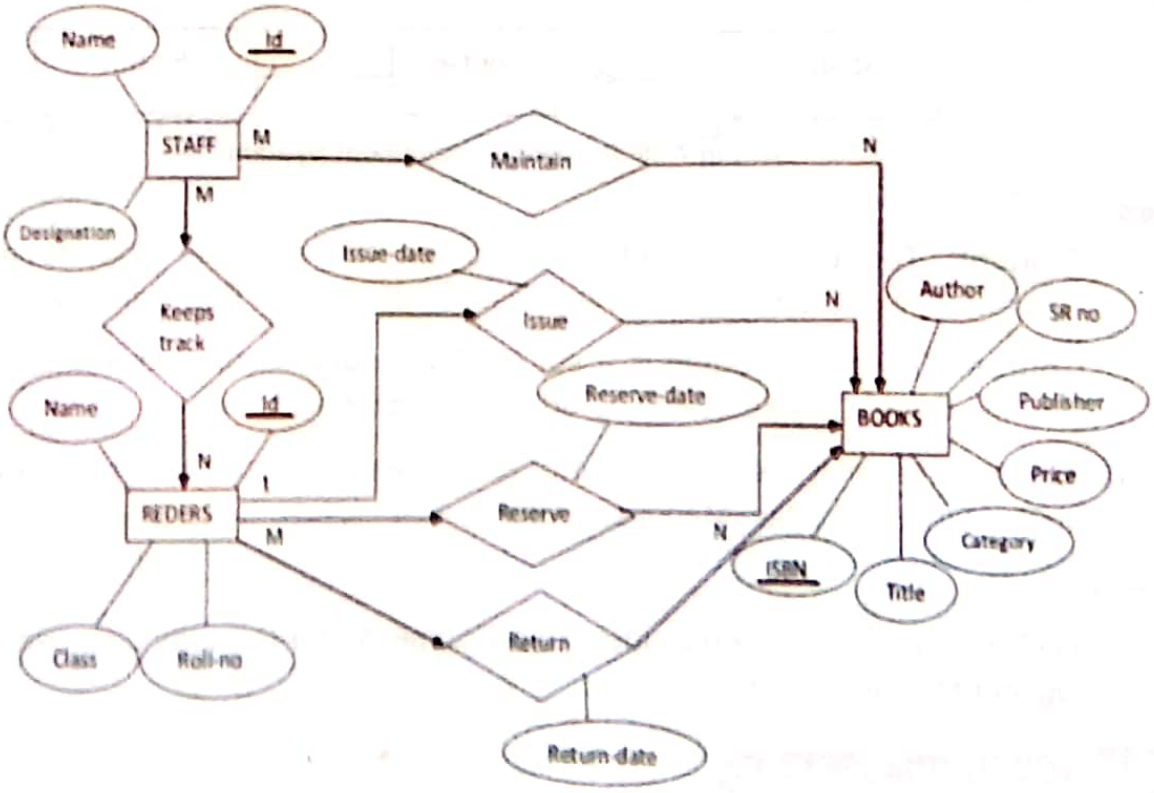


Fig.7.19 E-R Diagram for Library Management System

Entities

1. **STAFF**: The entity STAFF is the all staff of the library and its attributes are Id (primary key), Name and Designation.
2. **BOOKS**: The entity BOOKS is the all available books in the library. Its attributes are ISBN (primary key), Title, Category, Price, Publisher, Sr no and Author.
3. **READERS**: The entity READERS is all the members of the library. Its attributes are Id (primary key), Name, Class and Roll no.

Relationships

1. The relationship between Staff and Books is many-to-many because many staff members are maintaining the books.
2. The relationship between Staff and Readers is many-to-many because many staff members keep track of many readers.
3. The relationship between Readers and Books is one-to-many because a reader can borrow one or more books.
4. The relationship between Readers and Books is many to many as many readers can reserve and also return many books.

Student Management System

Student Management System registers students for various courses and stores and prints their results. It consists of three entities which are Student, Course and Result. E-R diagram for student management system is shown in Fig.7.20.

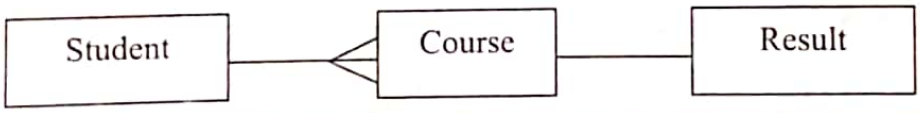


Fig.7.20 Student Management System

Entities

1. **Student:** The entity Student is set of all the students and its attributes are Admission_No, Student_Name, Address, DOB (Date of Birth) and Tel_No.
2. **Course:** The entity Course is a set of all the courses offered and its attributes are Course_Code, Course_Name, Credits, Semester and Year.
3. **Result:** The entity Result is a set of all the results of students and its attributes are Marks_Obtained, Max_Marks and Grade.

Relationships

1. The relationship between Student and Course is one-to-many because a student can register for one or more courses.

Teacher Point

Teacher should give some home assignments to the students at the end of the chapter.

2. The relationship between Course and Result is one-to-one because there is only one result for each course.

Ticket Booking System

Ticket Booking System has three entities. The entities are Airlines, Flights and Tickets. The E-R diagram for this is shown in Fig.7.21.

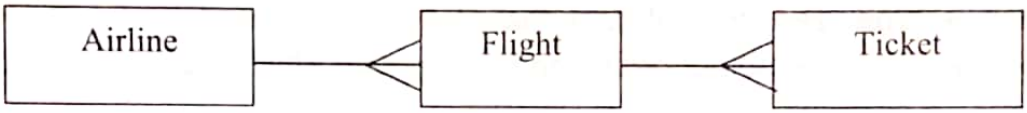


Fig.7.21 E-R Diagram of Ticket Booking System

Entities

1. **Airline:** The entity Airline is set of all the airlines and its attributes are Airline_Code and Airline_Name.
2. **Flight:** Attributes for Flight are Flight_Code, Departure_Location, Arrival_Location, Departure_Time, Arrival_Time, Departure_Date, Price and Seats_Available.
3. **Ticket:** Attributes for Ticket are Ticket_No, Passenger_Name, Address, Tel_No and Email_Address.

Relationships

1. The type of relationship between Airline and Flight is one-to-many because one airline has many flights.
2. The relationship between Flight and Ticket is also one-to-many since many tickets are booked for a single flight.

7.4.5 NORMALIZATION OF RELATIONAL DATABASE

Normalization is the process of organizing data in relational database in order to minimize duplication of information (data) and to safeguard the database against certain anomalies or irregularities. The basic purpose of normalization is to divide large relations/tables into smaller and well organized tables/relations and remove all kinds of anomalies from them. There are five normal forms to normalize a database.

Note: *The explanation of the normal forms is beyond the scope of this book. Students will learn them in higher classes.*

Key Points

- Data refers to facts and figures. It is raw material that is input in the computer for processing.
- Information is organized form of data that is meaningful and easily understandable by computer users. It is the output produced by computer after processing the data.
- A database is a collection of related data. A database consists of one or more data files and data files contain fields.
- A Database Management System (DBMS) is a collection of programs that enables users to create and maintain a database.
- Database administrator (DBA) is the person in charge for supervising the database and the use of DBMS in an organization.
- In a Relational Database Model, data is stored in tables and the tables are linked by means of common fields. Each column of table holds one field and each row one record. It is the most commonly used database model.
- All the information about one person or item is held is a record. When records are stored in tables, rows represent records and columns represent fields.
- Key is an attribute (or field) that is used to identify records in tables.
- Entity is a thing of interest to an organization about which data is to be held. For example employees in an organization or books in a library.
- Attribute is a property or characteristics of an entity.
- Relationship is a link between entities. In a relational database, it is the link between tables.
- Data modeling is the process of creating a conceptual data model that identifies the data needed by an organization to achieve its objectives.
- An instance in a database is the actual content of the database at a particular point in time.
- Cardinality refers to the maximum number to times an instance in one entity can be associated with instances in the related entity.
- Modality refers to the minimum number of times an instance in one entity can be associated with an instance in the related entity.
- Entity-Relationship (E-R) diagram is a diagrammatic way of representing the relationship between the entities of a database.

- Normalization is the process of organizing data in relational database in order to minimize duplication of information (data) and to safeguard the database against certain anomalies or irregularities.

Exercise

Q1. Select the best answer for the following MCQs.

i. Duplication of data in different files is called_____.

A. Data inconsistency
B. Data redundancy
C. Data overflow
D. Invalid data

ii. If data is not updated in a file in file based data management systems, what types of problem will it cause?

A. Data inconsistency
B. Data redundancy
C. Data overflow
D. Invalid data

iii. A record is also called_____.

A. Attribute
B. Entity
C. Property
D. Tuple

iv. An attribute is also called:

A. Record
B. Entity
C. Field
D. Relation

v. What is a thing of interest to an organization called about which data is to be held?

A. Field
B. Relation
C. Entity
D. Attribute

vi. In which type of database data is held in tables and tables are linked by common field?

A. Hierarchical Database
B. Network Database
C. Relational Database
D. Object-Oriented Database

vii. In which database model data is organized in tree-like structure?

A. Hierarchical Database
B. Network Database
C. Relational Database
D. Object-Oriented Database

viii. What refers to the maximum number of times an instance in one entity can be associated with instances in the related entity?

A. Relation
B. Cardinality
C. Modality
D. E-R diagram

ix. What refers to the minimum number of times an instance in one entity can be associated with an instance in the related entity?

A. Relation
B. Cardinality
C. Modality
D. E-R diagram

x. What is a key field called that is used in relationship between tables whose value matches a primary key in the other table?

A. Candidate key
B. Secondary key
C. Alternate key
D. Foreign key

Q2. Give short answers of the following questions.

i. Differentiate between data and information.
ii. Define a database.
iii. What is a Database Management System (DBMS)?
iv. What is a relational database?
v. Define primary and secondary key.
vi. Define attribute and entity.
vii. What is meant by instance?
viii. Differentiate between cardinality and modality.
ix. Why is it necessary to normalize a relational database?

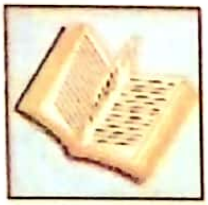
Q3. Give long answers of the following questions.

i. What are the advantages of using a DBMS over file management system?
ii. Define Database Administrator and describe the tasks performed by him.
iii. Define database model and explain its types.
iv. Describe the steps involved in database design.
v. What is an E-R diagram? Explain with examples.

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. A city has many universities and each university has many departments. Each department has many teachers. Define the attributes for the entities, university, department and teacher and draw the E-R diagram.
2. A company sells many products to their customers. There are many suppliers who supply various products. Draw the E-R diagram of entities, company, supplier and customer.
3. An institute offers many courses. A student is allowed to register in only one course at a time. An instructor teaches many courses. Draw the E-R diagram of entities, courses, student and instructor.
4. A city has many Cable TV companies. Each company has many TV channels. A customer subscribes Cable TV from only one company. Draw the E-R diagram of entities, Cable TV Company, channels and customer.



8

DATABASE DEVELOPMENT

After completing this lesson, you will be able to:

- Identify various relational database management systems
- Describe the steps involved in creating and saving a database
- Describe database toolbar, database window and Objects (tables, queries, forms and reports)
- Work with tables (create, add and edit tables in database, identify data types, create primary and foreign keys, create and edit relationship among tables, navigate through records in a table and add, modify and delete records.
- Work with forms (create, save and edit a form, know different form views, navigate through records displayed in a form, add, modify and delete records)
- Work with queries (create, save, edit and edit queries)
- Generate and customize reports

Reading

UNIT INTRODUCTION

This unit is dedicated to relational database management systems. It provides practical training for developing database management systems using Access software by creating tables, forms, queries and reports.

8.1 INTRODUCTION

Databases are developed to provide facilities to store, manage and retrieve information in an organized way. Relational databases have been very successful in organizations for managing databases. In relational databases, data is stored in tables. The relations between the tables make it a relational database. Database development includes the creation of database objects (tables, forms, queries, reports, etc.), keys and relationships between the tables.

8.1.1 DATABASE MANAGEMENT SYSTEMS

There are different relational database management systems (RDBMS). These are Microsoft Access, OpenOffice Base, SQL Server, Oracle and Informax, etc.

Microsoft Access

It is one of the popular database software by Microsoft. To understand the basic concepts of database management, Microsoft Access 2007 will be discussed in section 8.1.2 in this book.

OpenOffice Base

OpenOffice Base is the database module of OpenOffice Suite. It is an open source application program. OpenOffice Base is a fully featured database management system.

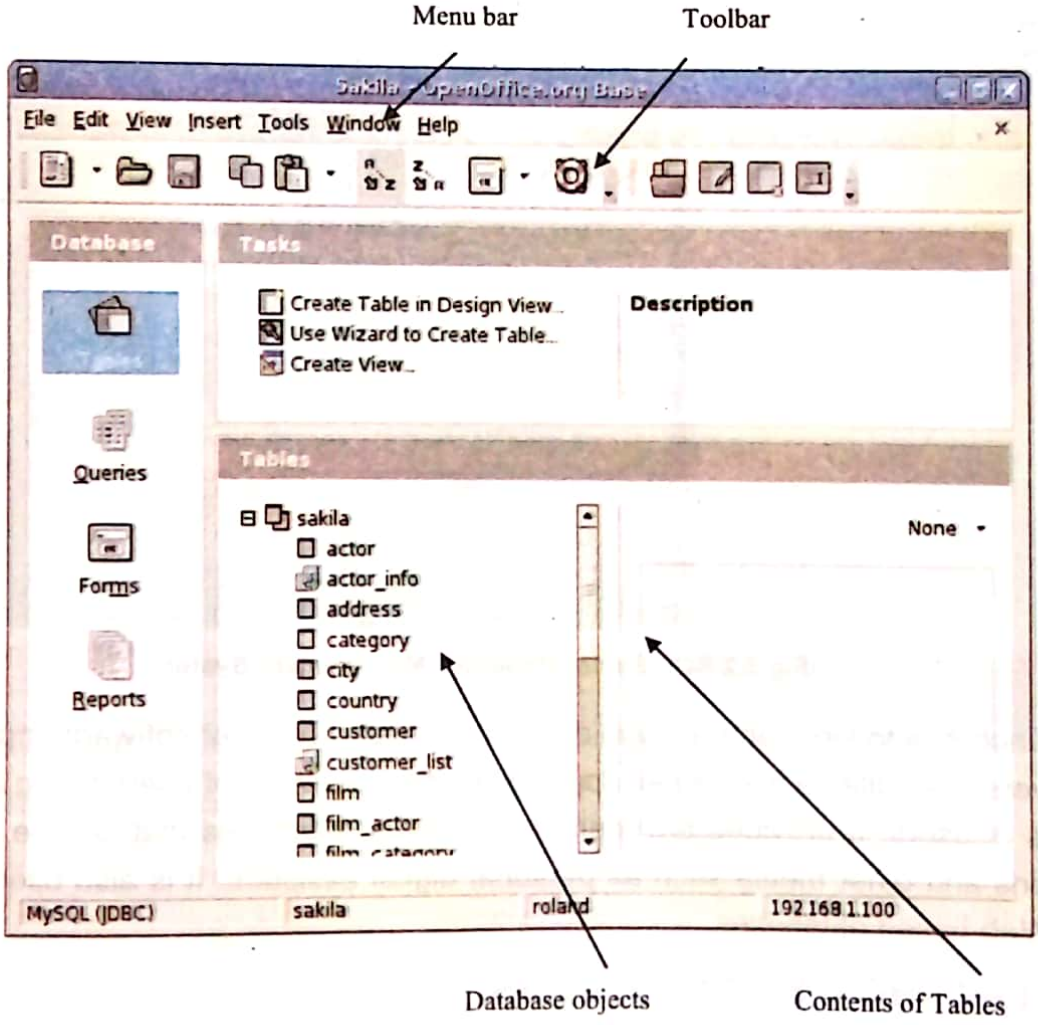


Fig.8.1 OpenOffice Base Database Management System

It features wizards to help new users to create database design, that is, to create tables, queries, forms and reports. It allows users to create interactive databases where they can manage data related to payroll, inventory, assets, budgets, customers, sales orders and invoices, etc.

Teacher Point

Teacher should explain the different database management systems with examples.

The information in OpenOffice databases can be exported to other database programs and also to other OpenOffice programs.

SQL Server

SQL Server is a product of Microsoft Office. It is a relational database management system that offers a variety of tools for database development, maintenance and administration.

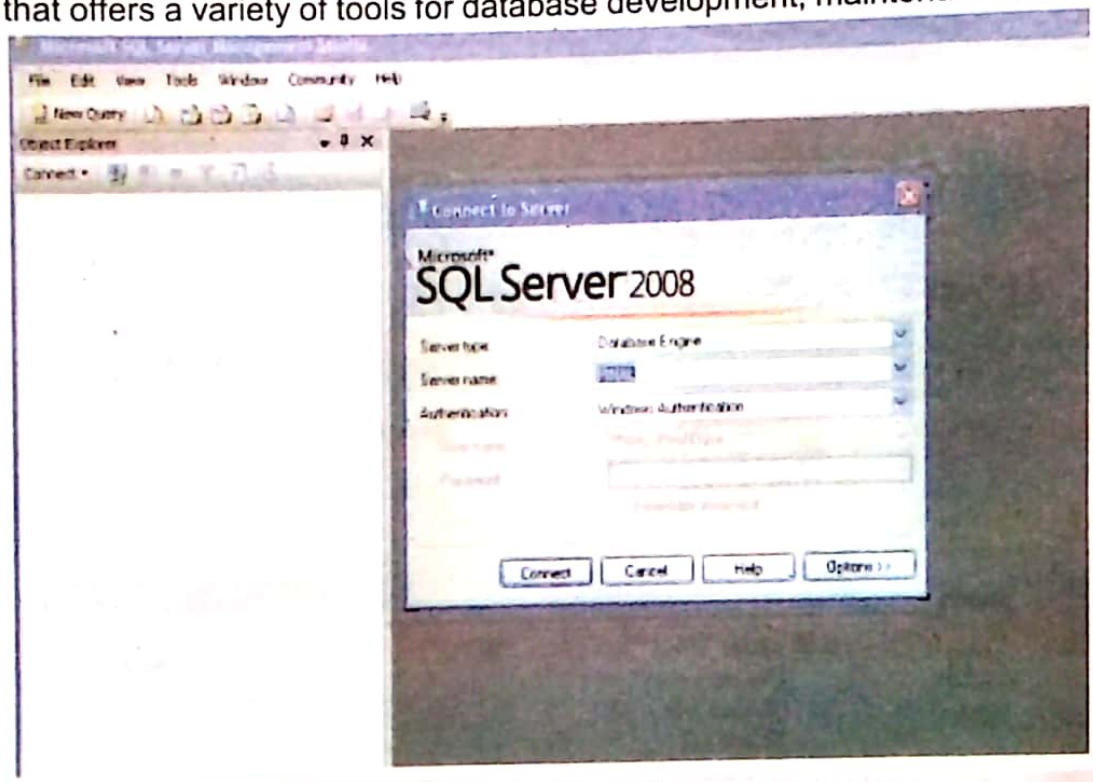


Fig.8.2 SQL Server Database Management System

Its main function is to store and retrieve data as requested by other software applications. It has different versions suitable from small applications for a number of users to big applications for thousands of users. It provides environment to create databases that can be accessed from workstations and other media such as personal digital assistant. It is also used to create and manage Web-based databases.

8.1.2 SELECTING A SUITABLE DBMS

In this book, Microsoft Access 2007 is selected for learning how to create and manage a database. Microsoft Access is popular worldwide and it is most suitable for beginners to learn how to develop and manage a database. It is already installed on many computers when purchased and it is easily available to purchase.

The Access Window

The Access Ribbon located near the top of the Access Window, is the control center in Access as shown in Fig.8.3. The ribbon provides easy way to perform tasks while creating a database object. There is a row of ribbon tabs with headings such as Home, Create, External Data and Database Tools. The Home tab contains the more frequently used commands. Clicking

on each tab presents you with its own individual ribbon with its own particular icons. Each icon on a ribbon is contained within a group of icons that perform similar tasks. For example, to display the Create tab, click Create on the ribbon. The Create tab has groups for Tables, Forms, Reports and Other.

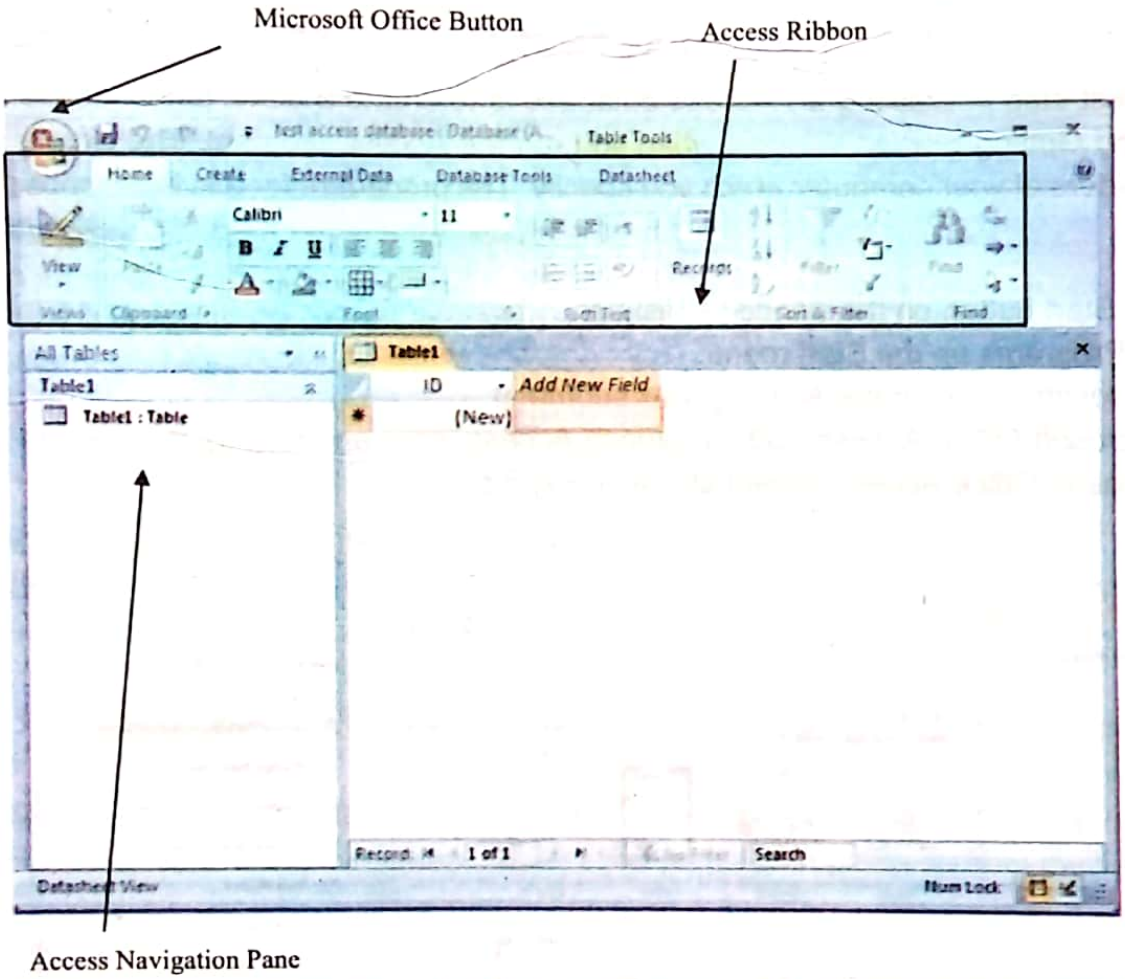


Fig.8.3 Microsoft Access Window

Microsoft Office Button

The Microsoft Office Button that is shown above is located in the top left corner of the Access Window. You click this button to perform tasks such as saving, opening, new file creation and printing, etc. To the right of this button is the Quick Access Toolbar that provides quick access to some more commonly used commands in Access 2007. There are three default icons on this toolbar, save, undo, redo, which are very similar to Microsoft Word program. You can customize this toolbar to add additional commands.

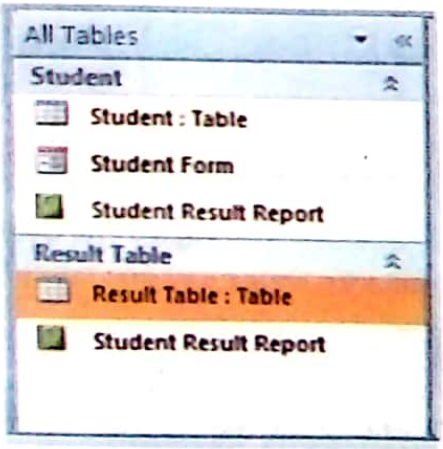


Fig.8.4 Access Navigation Pane

Access Navigation Pane

The Access Navigation Pane displays icons for all the tables, forms, queries and reports that you create as shown in Fig.8.4. When you want to open any database object, you just click one of these icons and the required object will open in the main Access window.

8.1.3 CREATING AND SAVING AN ACCESS DATABASE

The first step in creating an Access database is to create a blank database file. This is done from the Getting Started Window when you run the Access program. The file is saved in one of the folders of your computer which you specify. The procedure for this is described below.

Launching Access 2007

1. Click the Start button on the Windows taskbar.
2. Click All Programs on the Start menu.
3. Click Microsoft Office on the All Programs submenu.
4. Click Microsoft Office Access 2007 to launch Access 2007 and display the Getting Started with Microsoft Office Access screen shown in Fig.8.5

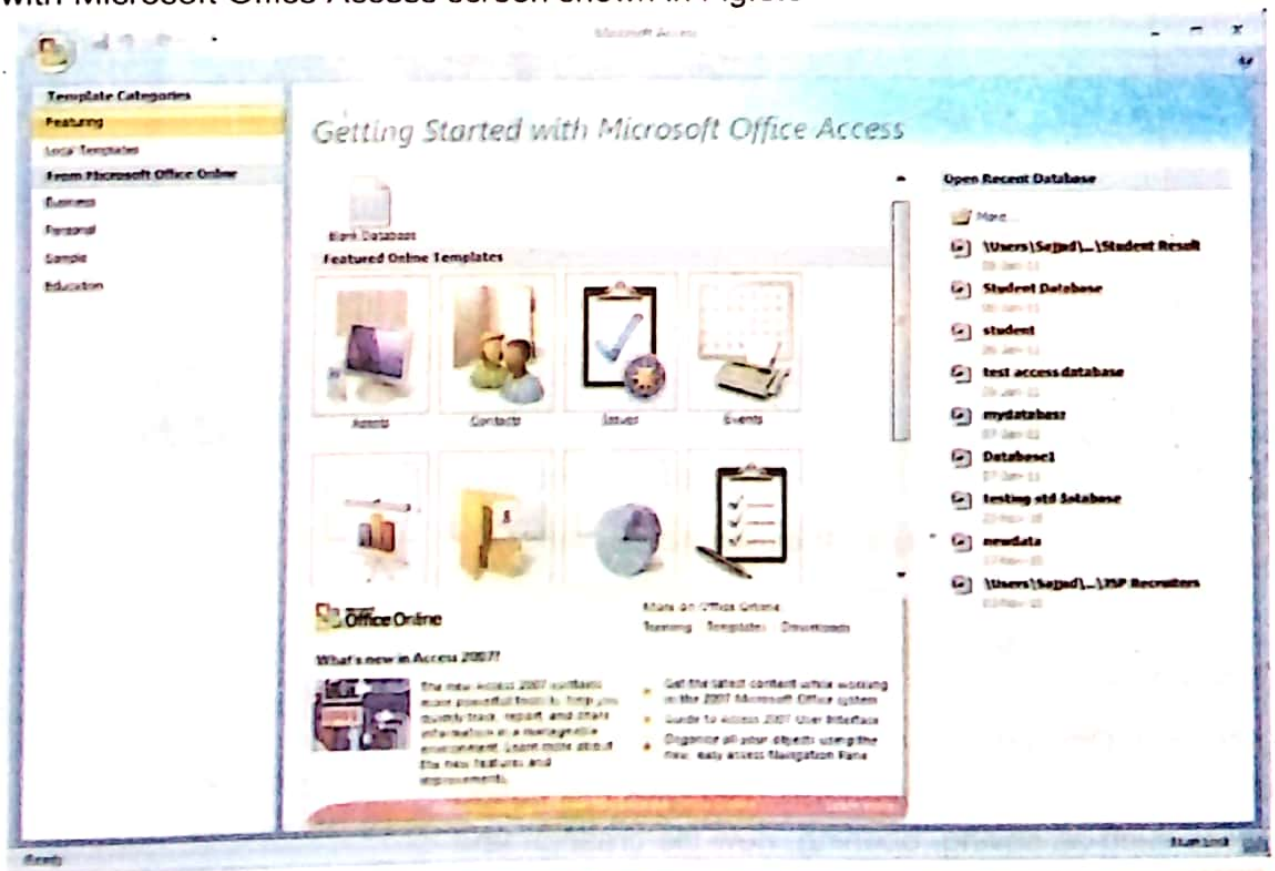


Fig.8.5 The Getting Started with Microsoft Office Access screen

Teacher Point

Teacher should assist students to develop few small database management systems like Library management system, School management system and Flight reservation system, etc.

Select Blank Database Template

This icon is on the top left of the Getting Started with Microsoft Office Access screen. Click the Blank Database icon to bring the Blank Database side bar on the right side of the screen as shown in Fig.8.6.

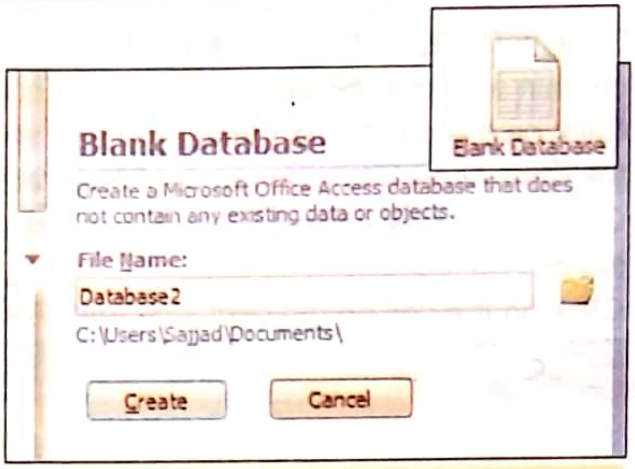


Fig.8.6 Blank Database Side Bar

Enter Filename for your Access Database

1. Enter a file name for database file.
2. Click the folder icon and browse for selecting a location for saving your database.
3. Click the Create button to create and save your database.

The database you just created will open for you to work on.

8.1.4 DATABASE OBJECTS

The following are the main objects used in Access.

Tables: Access stores all the information of a database in one or more tables. Information stored in tables is very similar to the Excel worksheet. Information in tables is organized in rows and columns.

Forms: A form is a window that is used for viewing, modifying or deleting data that is stored in tables and for adding new data.

Queries: Queries are used to gather selected information from a database and organize it either for use in reports or for viewing on screen. A query can combine information from multiple tables.

Reports: Reports are used for printing information from a database. A report can combine data from more than one table.

8.2 WORKING WITH TABLES

Like all the relational databases, Access stores data in tables. Each horizontal row represents a record and each vertical column represents a table field. Each row of table is a record of a particular person, item, product, etc.

8.2.1 CREATING, SAVING AND EDITING A TABLE

We are going to create a Student Database Management System. This database consists of two tables, a form, queries and reports. The two tables are STUDENT table and RESULT table. STUDENT table will store students' particulars and RESULT table will store their results of various examinations throughout the year.

Creating the STUDENT Table

1. Click the Create tab.
2. Click Table Design icon in the Tables group to bring the table design grid shown in Fig.8.7.

3. Enter STUDENTID below Field Name in the first row as shown in Fig.8.8. This field will contain a unique reference number for each student.
4. Click on the cell below Data Type and select AutoNumber from the drop-down list because we want Access to automatically generate a unique reference number for each student.
5. On the next row enter STD NAME (Student Name) in the column that has the heading Field Name.
6. Click on the cell on the right side and select Text data type which is default.

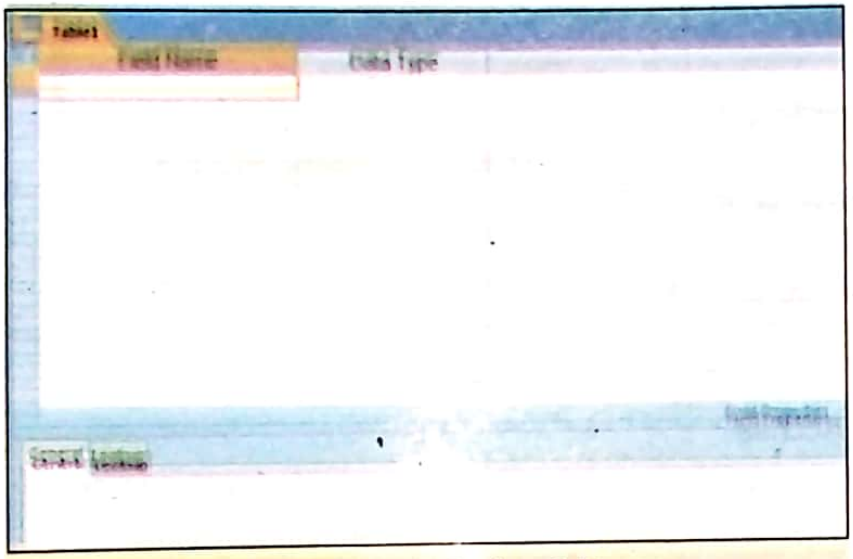


Fig.8.7 Table Design Grid

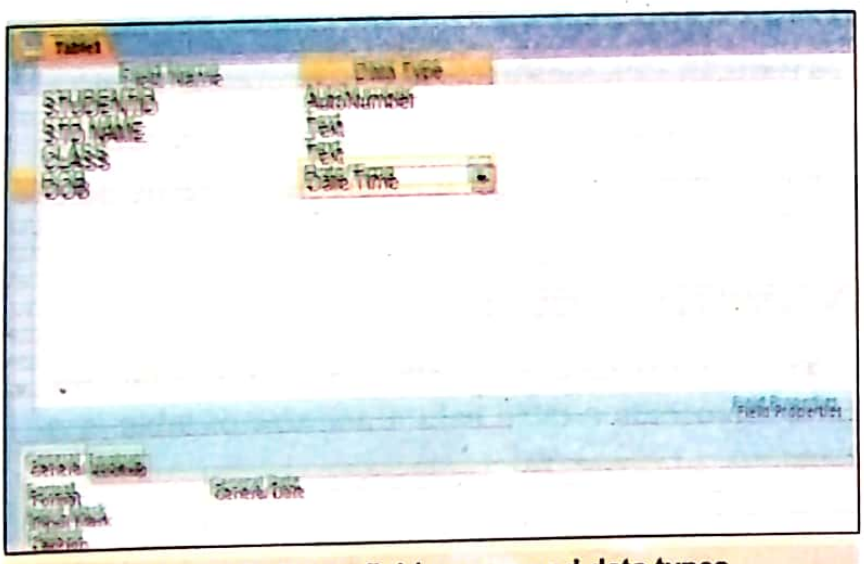


Fig.8.8 Defining field names and data types

7. Enter 10 in the cell on the right side of Field Size in the Field Properties section to allow maximum 10 characters for a student name.

In a similar manner enter the fields CLASS, DOB (Date of Birth) and CITY. Data type of CLASS is Text of field size 6, data type of DOB is Date/Time. After selecting the Date/Time data type for DOB, click on the cell on the right side of Format in the Field Properties section and select General Date from the drop-down list as shown in Fig.8.8. Finally enter the CITY field name with data type Text having field size 10.

Before you save the table, choose the Primary key, which in this case is STUDENTID. To do this:

1. Select STUDENTID row by clicking on it.
2. Click the Primary Key icon in the Tools group.
3. Save the table by clicking the save icon on the top left of the screen above the Access Ribbon.
4. Name the table STUDENT in Save As dialog box and click OK.

Now enter data in the table in datasheet view, just like you enter in an Excel worksheet. Double click on the STUDENT table in the Navigation Pane and enter the data in the table that is shown in Fig.8.9.

STUDENT

STUDENTID	STD NAME	CLASS	DOB	CITY	Add New
1	ZAHEER	XI-A	12-May-96	ISLAMABAD	
2	MANSOOR	XI-B	24-Aug-95	RAWALPINDI	
3	JAVED	XI-A	01-Mar-96	ISLAMABAD	
4	KHURRAM	XI-A	22-Feb-95	TAXILA	
5	HASEEB	XI-B	12-Sep-95	RAWALPINDI	
6	ZEESHAN	XI-B	28-Dec-95	ISLAMABAD	
(New)					

Fig.8.9 Entering records in STUDENT table

1. Click in cell below STD NAME and enter ZAHEER.
2. Press right arrow key to move to CLASS column and enter XI-A.
3. Press right arrow key again and enter 12.5.96 in DOB column.
4. Press right arrow to move to the CITY column and enter ISLAMABAD. The General Date format will be automatically applied to the date which you specified when you created this field.

As soon as data is entered in the STD NAME field of first record, STUDENTID field automatically gets the value 1 and whenever a new record is entered, it is incremented by one. You never have to enter value for this field.

Enter all the 6 records in the student table following the same method. Data in records is automatically saved.

Creating the RESULT Table

Create the RESULT table just as you created the STUDENT table having the fields data types and field size given in Fig.8.10.

Filed Name	Data Type	Field Size
RESULTID	Number	Long Integer
EXAMINATION	Text	10
MATHS	Number	Integer
PHYSICS	Number	Integer
COMPUTER	Number	Integer

Fig.8.10 Fields of RESULT table with their data types

The first field, RESULTID is a foreign key field and it will be used later to link this table with the STUDENT table using the STUDENTID primary key. The field size of both STUDENTID and RESULTID must be the same which is Long Integer. The second field in EXAMINATION will

store the name of the examination such as MID-TERM, FINAL, etc. The last three fields, MATHS, PHYSICS and COMPUTER will store the marks of these subjects and their data type is Integer. Integer data type is selected for these fields from the Fields Properties section in Design View. To select Integer data type click on the cell on the right side of Field Size, open the drop-down menu and select Integer. If you select Long Integer for these fields, it will occupy more memory.

Editing the Structure of a Table

User can edit the structure of a table in the Design View. This is shown in Fig.8.11

- In Design View, you can add, insert or delete fields.
- To delete a field, click the selection box on the left side of the field and press the Delete key.
- To add a new record, enter the field name below the last field and specify its data type.
- To insert a new field, click the selection box of the field name before which you want to insert the new field and press the Insert key. You can also modify the field names.

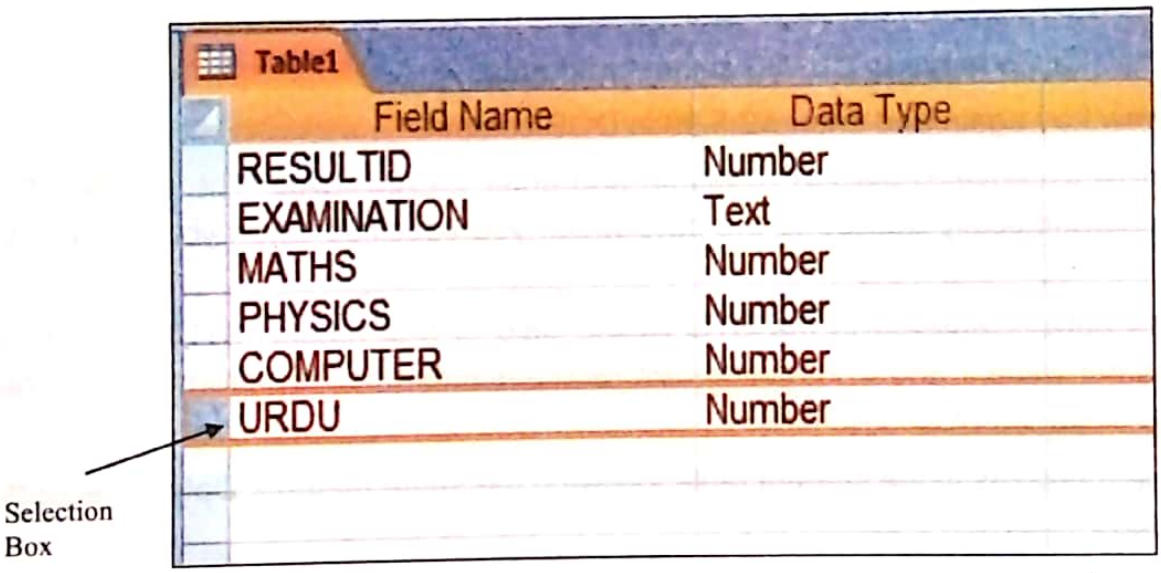


Fig.8.11 Editing structure of table

8.2.2 DATA TYPES IN ACCESS

There are seven types of field data types which are commonly used in Access.

1. Text: Text fields are most common, so Access assigns Text as the default data type. A Text field can contain as many as 255 characters and you can designate a maximum length less than or equal to 255. Access assigns a default length of 50 characters.

2. Memo: Memo fields ordinarily contain as many as 65,535 characters. You use them to provide descriptive comments. Access displays the contents of Memo fields in a Datasheet view. A memo field cannot be a key field.

3. Number: Various numeric data subtypes are available in the Field Properties pane of Table Design window. Choose the appropriate data subtype by selecting one of the Field Size property

settings. You specify how to display the number by setting its Format property to one of the formats.

4. AutoNumber: An AutoNumber field is a numeric (Long Integer) value that Access automatically fills in for each new record you add to a table. Access can increment the AutoNumber field by 1 for each new record or fill in the field with a randomly generated number, depending on the New Values property setting that you choose. The maximum number of records in a table that can use the AutoNumber field is slightly more than 2 billion.

5. Yes/No: Logical fields in Access use -1 for Yes (True) and 0 for No (False). You use the Format property to display Yes/No fields as Yes or No, True or False, On or Off or -1 or 0.

6. Currency: Currency is a special fixed format with four decimal places designed to prevent rounding errors that would affect accounting operations where the value must match to the penny.

7. Date/Time: Dates and times are stored in a special fixed format. The date is represented by the whole number portion of the Date/Time value and the time is represented by its decimal fraction. You control how Access displays dates by selecting one of the Date/Time Format properties.

The other two data types, OLE object and Hyperlink are beyond the scope of this book therefore they will not be explained here.

Depending on the specific data type that you choose for a field, you can set additional properties for a table field. You set these additional properties on the General page of the Table Design window's Field Properties pane by selecting from drop-down or combo lists or by typing values in text boxes.

When you have defined all the fields that you want to include in your table, you must save it. When you close the Table Design window, it will ask you whether you want to save it or not. Select save and give your table a name. You can also save it by clicking the save icon on the top left corner of the screen.

8.2.3 CREATING PRIMARY KEY AND FOREIGN KEY

After defining all the field names and their data types in Design View, create a primary for the table as shown in Fig.8.12.

1. Select the field name STUDENTID by clicking the selection box on the left side of the field name.
2. Click the primary key icon on the Tools group of Design tab.

In our project of Student Database Management System, we are going to make RESULTID field the foreign key when we create relationship between the STUDENT table and the RESULT table.

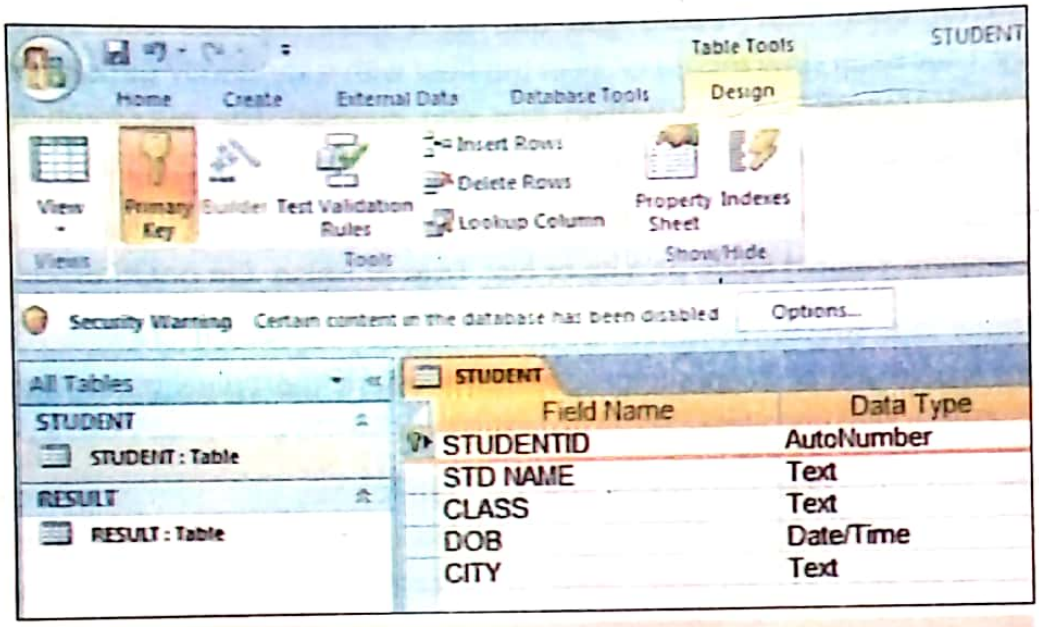


Fig.8.12 Creating primary key for STUDENT table

8.2.4 CREATING AND EDITING RELATIONSHIP BETWEEN TABLES

A database can contain many tables. The reason to put more than one table into a database is that it is easier to manage data if all the information about a particular subject is in its own table. For example, in our Student Database Management System, we have created two tables, one for holding students' particulars and the other for holding their results of various examinations throughout the year.

The connection between a field in one table and a field in another table must be defined within Access. Such a definition is known as a relationship and each of the fields is said to be related to the other field. Once a relationship has been designated, Access can help you maintain the integrity of the related data and can make it easier to access related data. Relationships also allow you to create queries, forms and reports that display information from several tables at once.

Creating Relationship between STUDENT and RESULT Tables

We are going to create a one-to-many relationship between the STUDENT table and the RESULT table. This requires that primary key field, STUDENTID of the STUDENT table must have a unique value but the values in the foreign key field, RESULTID can match many entries in the related field of the existing table to represent results of various examinations. Note that the data type for STUDENTID should be AutoNumber and the data type of RESULTID should also be a number but it can have duplicate values.

The steps for creating relationship are given below.

Click the Relationship icon in the ribbon of Database Tools as shown in Fig.8.13

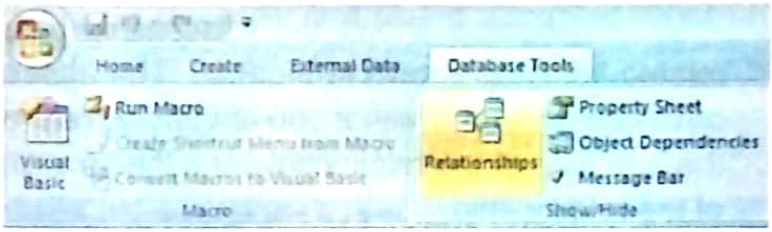


Fig.8.13 Icon for creating relationship

1. Click the STUDENT table and click the Add button shown in Fig.8.14
2. Click the RESULT table and click the Add button.
3. Click the Close button to close the dialog box.
4. Move the mouse pointer to the primary key STUDENTID and drag it to the foreign key RESULTID in the RESULT table.

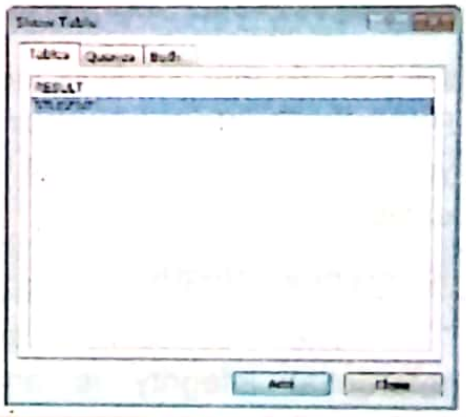


Fig.8.14 Show Table dialog box for adding tables

1. Release the mouse button to display the Edit Relationship dialog box shown in Fig.8.15.
2. Check the Enforce Referential Integrity, Cascade Update Related Fields and Cascade Delete Related Records boxes.
3. Click the Create button to finish the job.

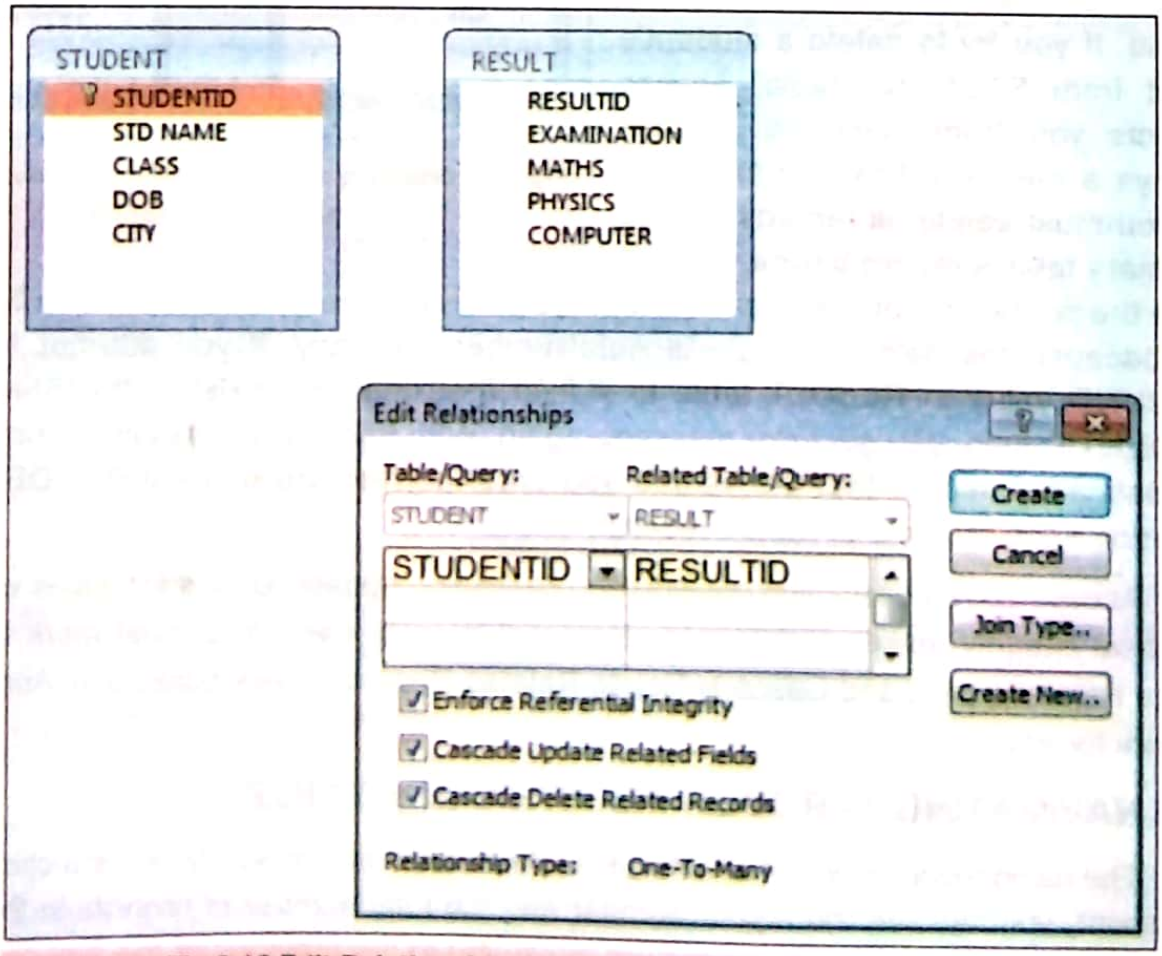


Fig.8.15 Edit Relationship dialog box for creating relationship

Access shows the relationship between two tables as a join line connecting the related fields as shown in Fig.8.16. The appearance of the line indicates the type of join you have chosen and whether you are forcing referential integrity. The small 1 indicates the table on the one side of the relationship and the small infinity sign indicates the table on the many side of the relationship.

Editing Relationship among Tables

To change relationship between tables, click Relationship in the Database Tools tab. Click the join line that connects the fields. When you select the join line, the line becomes darker. Press the Delete key to clear the existing relationship. Click Yes when the message box asks you to confirm your deletion. Now recreate the relationship by using the procedure described earlier.

Referential Integrity

The capability to enforce referential integrity is an important feature of Access. Referential integrity enforcement prevents you from deleting or modifying values of a primary table's record on which related records depend. If you try to delete a student's record from STUDENT table, Access prevents you from doing so. Access displays a message box informing you that you must delete all records related to primary table's record before you can delete the primary record. You cannot change a value in the STUDENT table's STUDENTID field because the field data type is AutoNumber. Similarly, if you attempt to change a RESULTID value in RESULT table to a field that does not exist in the Student table's STUDENTID field, you get error message again. With referential integrity enforced, Access automatically ensures that the values you enter correspond to valid STUDENTID value when you save the new or edited record.

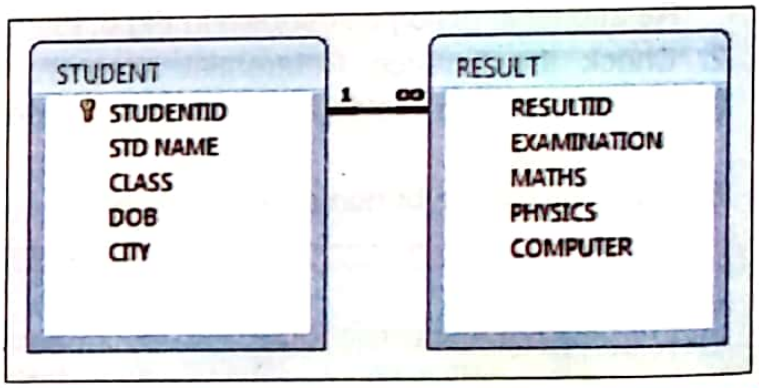


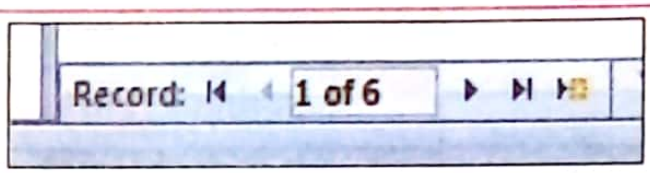
Fig.8.16 One-to-many relationship between STUDENT and RESULT tables

Access 2007's cascading deletion and cascading update options for tables with enforced referential integrity makes maintaining referential integrity easy. You must mark the Cascade Update Related Fields and Cascade Delete Related Records check boxes and Access does all the work for you.

8.2.5 NAVIGATING THROUGH RECORDS IN A TABLE

The navigation buttons of a table are at the bottom left corner. When you click at any field of a record, you can see the record number and the total number of records in the table. The button to the left of the record number will move you to the previous or the first record and the

button to the right will move you to the next or the last record in the table. The last button on the right side will allow you to enter a new record. You can also enter a new record by clicking the New icon in the Records group on the Home tab.



8.2.6 ADDING, MODIFYING AND DELETING RECORDS

Adding Records in a Table

The following are the steps for adding new records in a table.

1. Right click on the table in the Navigation Pane in which you want to add new record and select Open option or double click it.
2. Click the New button in the Records group of Home tab or click the new record button in the navigation bar at the bottom left of the screen. This will move the pointer to the first blank row after the last record.
3. Enter the data for the new record.

Adding Records in a Related Table

The following are the steps for adding records in RESULT table which is related with STUDENT table.

1. Open the STUDENT table by double clicking it in the Navigation Pane.
2. Click the "+" symbol at the left end of the first row in STUDENT table.
3. Add data for the related record of RESULT table as shown in Fig.8.17. You can add results of more than one examination in the RESULT table since there is one-to-many relationship between the STUDENT table and the RESULT table.

STUDENT

STUDENTID	STD NAME	CLASS	DOB	CITY
1	ZAHEER	XI-A	12-May-96	ISLAMABAD

EXAMINATIC	MATHS	PHYSICS	COMPUTER

2	MANSOOR	XI-B	24-Aug-95	RAWALPINDI
3	JAVED	XI-A	01-Mar-96	ISLAMABAD
4	KHURRAM	XI-A	22-Feb-95	TAXILA
5	HASEEB	XI-B	12-Sep-95	RAWALPINDI
6	ZEESHAN	XI-B	28-Dec-95	ISLAMABAD
(New)				

Fig.8.17 Adding record in a related table

4. When you click the "+" symbol it changes to "-" symbol. If you click it again, you will return to the STUDENT table and the "-" symbol will change to "+" symbol again.

Modifying Records in a Table

For modifying the information in a cell, just click the cell containing the data that you want to change. Delete or type over the old data and enter the new data. When you are editing data, you will see a pencil symbol appears on the far left of the table on the row you are editing as

STUDENT

STUDENTID	STD NAME	CLASS	DOB	CITY
1	ZAHEER	XI-A	12-May-96	ISLAMABAD
2	MANSOOR	XI-B	24-Aug-95	RAWALPINDI
3	JAVED	XI-A	01-Mar-96	ISLAMABAD
4	KHURRAM	XI-A	22-Feb-95	TAXILA
5	HASEE	XI-B	12-Sep-95	RAWALPINDI
6	ZEESHAN	XI-B	28-Dec-95	ISLAMABAD
(New)				

Fig.8.18 Modifying a record

shown in Fig.8.18. When you finish editing data in a row and move out of the row, the changes will be saved automatically and the pencil will disappear.

Deleting Records from a Table

The following are the steps for deleting records from a table.

1. Open the table from which you want to delete record.
2. Select the record you want to delete by clicking its row selector box which is on the left end of the row.
3. Press the Delete key or choose Delete from the Records option on the Home tab.
4. Click the Yes button to proceed with the deletion in the dialog box that appears.

You can select and delete multiple records by selecting them by clicking the row selector and dragging it up or down and then pressing the Delete key.

Once you delete a record and click Yes button to confirm your action, you won't be able to restore the record. You cannot undo a record deletion by choosing Undo from the Quick Access Toolbar. If you ever want to restore a deleted record you will have to reenter it from the scratch.

One or more columns of a table can be deleted in a similar way as deleting records. Keep in mind the distinction between deleting a row (record) which is all the fields of information about a single entry and deleting a column for every record in the table. It is generally easier to reenter a record than a field for all the records.

When a record in a table is deleted that is related to another table, Access might need to delete one or more records in the related table to enforce referential integrity. Before doing so, it will display a message. At this point, you must determine whether you want Access to delete the additional records which you cannot currently see.

8.3 WORKING WITH FORMS

Access forms create the user interface to your table. Although you can use datasheet view to perform many of the same functions as forms, forms offer the advantage of presenting data in an organized and attractive manner. A form is a tool that makes it easy to view, modify or delete information stored in one or more tables in a database. You can also add new records using a form. You can arrange the location of fields on a form so that data entry or editing operations for a single record follow a left-to-right, top-to-bottom sequence.

A form is constructed from a collection of individual design elements called controls or control objects. Controls include text boxes, labels and frames. Controls are the components you see in the windows and dialog boxes of Access and other Windows applications. You use text boxes to enter and edit data, labels to hold field names and object frames to display graphics. You can use different ways of creating forms by selecting various options in the Forms group which is on the Create tab of Access ribbon. We will use the Form Wizard to create a form.

8.3.1 CREATING, SAVING AND EDITING A FORM

The following are the steps for creating form from for the STUDENT table using Form Wizard.

1. Click the Create tab on the Access Ribbon as shown in Fig.8.19
2. Select More Forms from the Forms group.
3. Select Form Wizard from the drop-down list.

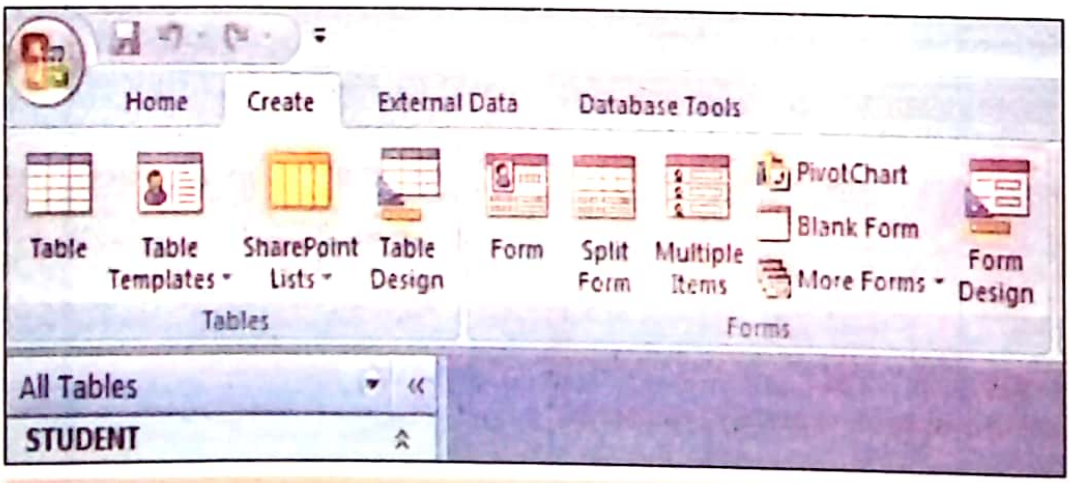


Fig.8.19 Access ribbon showing icons of Forms group on the right side

4. In the Form Wizard dialog box shown is Fig.8.20, select the STUDENT table from the Tables/Queries list box.

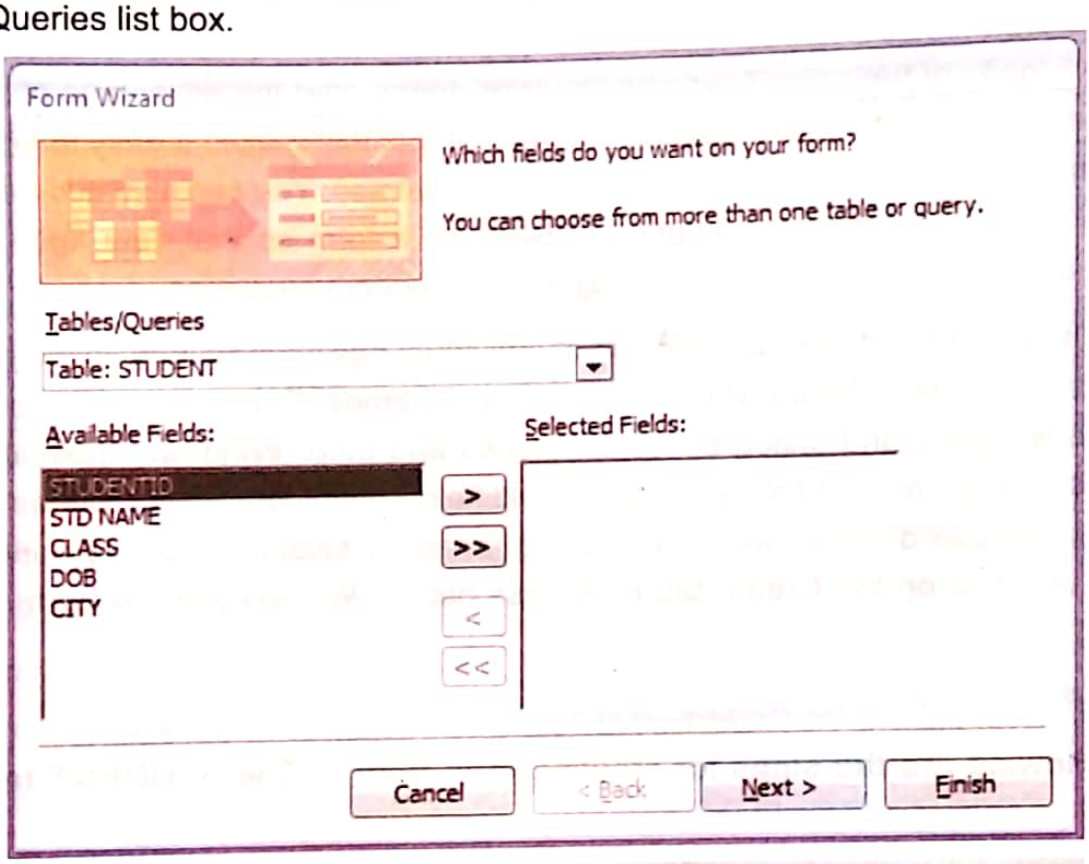


Fig.8.20 Form dialog window for selecting fields

5. Use the buttons as needed to move the name for each of the fields you want from the Available Fields list to the Selected Fields list.

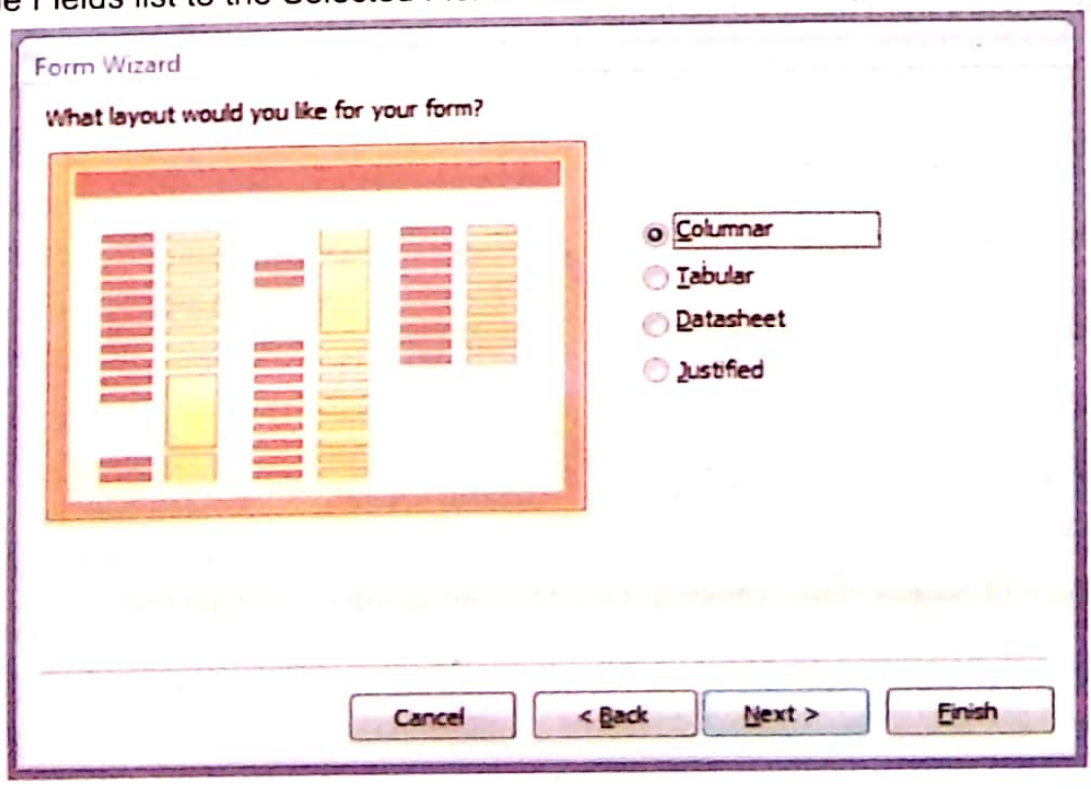


Fig.8.21 Form dialog box for selecting layout

Click the Next button to display the second Form Wizard dialog box shown in Fig.8.21.

Select columnar layout for your form and click Next to open the dialog box shown in Fig.8.22 for selecting form style.

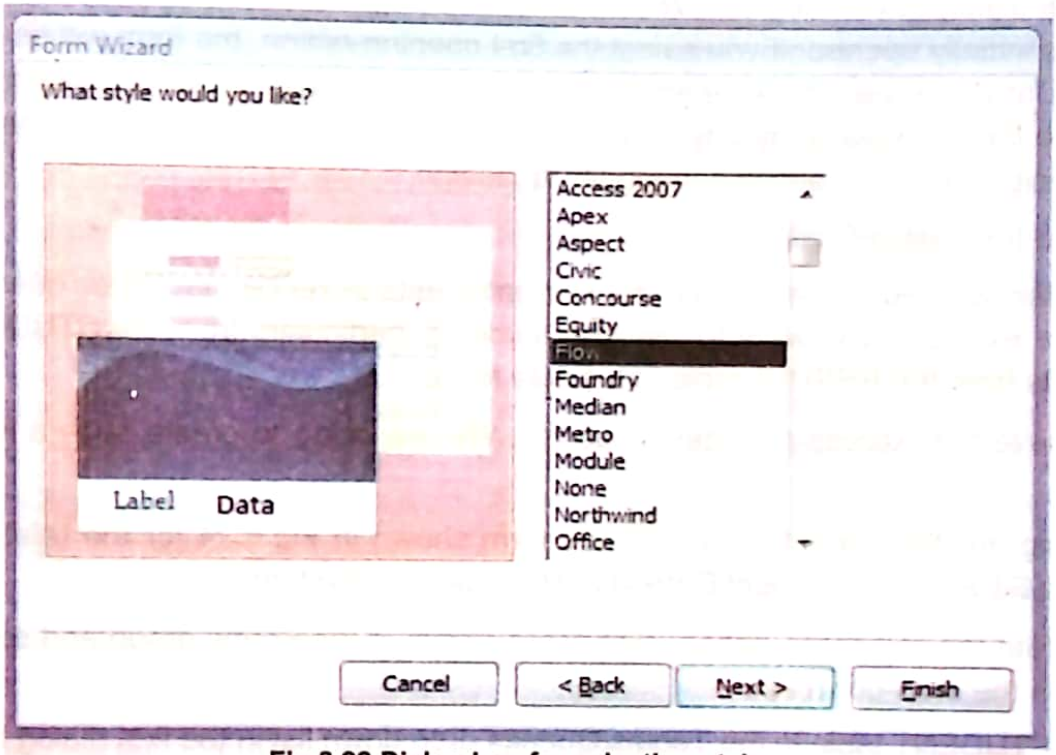


Fig.8.22 Dialog box for selecting style

Select a form style and click Next button to open the final dialog box shown in Fig.8.23.

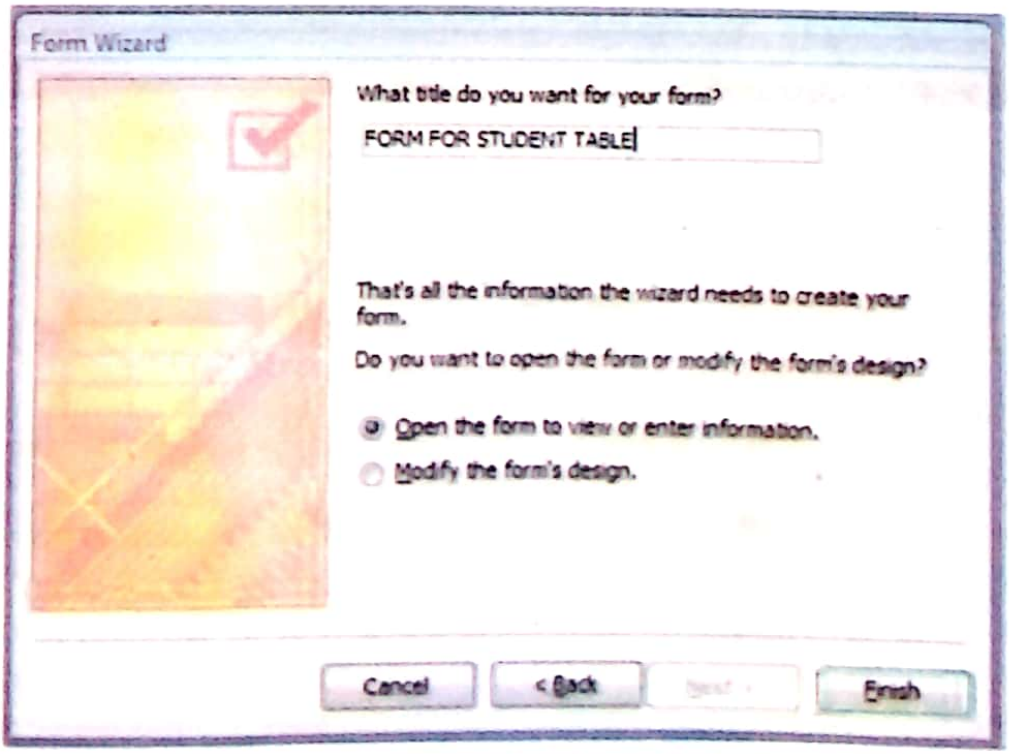


Fig.8.23 Dialog box for naming the form

Enter a title for your form and select one of the opening options to open the form after it is saved and click the Finish button to save the form.

The final dialog box in the Form Wizard lets you assign a title to the form and choose the way the form is initially opened. If you select the first opening option, the form will be opened in Form view (or Datasheet view if you selected Datasheet view layout) so that you can immediately begin using the form to view or modify data. If you select the second opening option, the form will open in Design view so that you can modify its design.

Creating Form for Related Tables

Very often we need to view data from or enter data in related tables or queries at the same time. For example, you want to view the students' particulars from the STUDENT table and their results from the RESULT table in a single form.

To achieve this Access provides subforms. We are going to create such a form using Form Wizard.

Following are the steps for creating the form shown in Fig.8.24 for the related tables, STUDENT and RESULT, in Student Database Management System.

1. On the Create tab of Access ribbon, click More Forms in the Forms group and select Form Wizard from the drop-down list.
2. Select the STUDENT table in the Tables/Queries drop down list in the first dialog box.

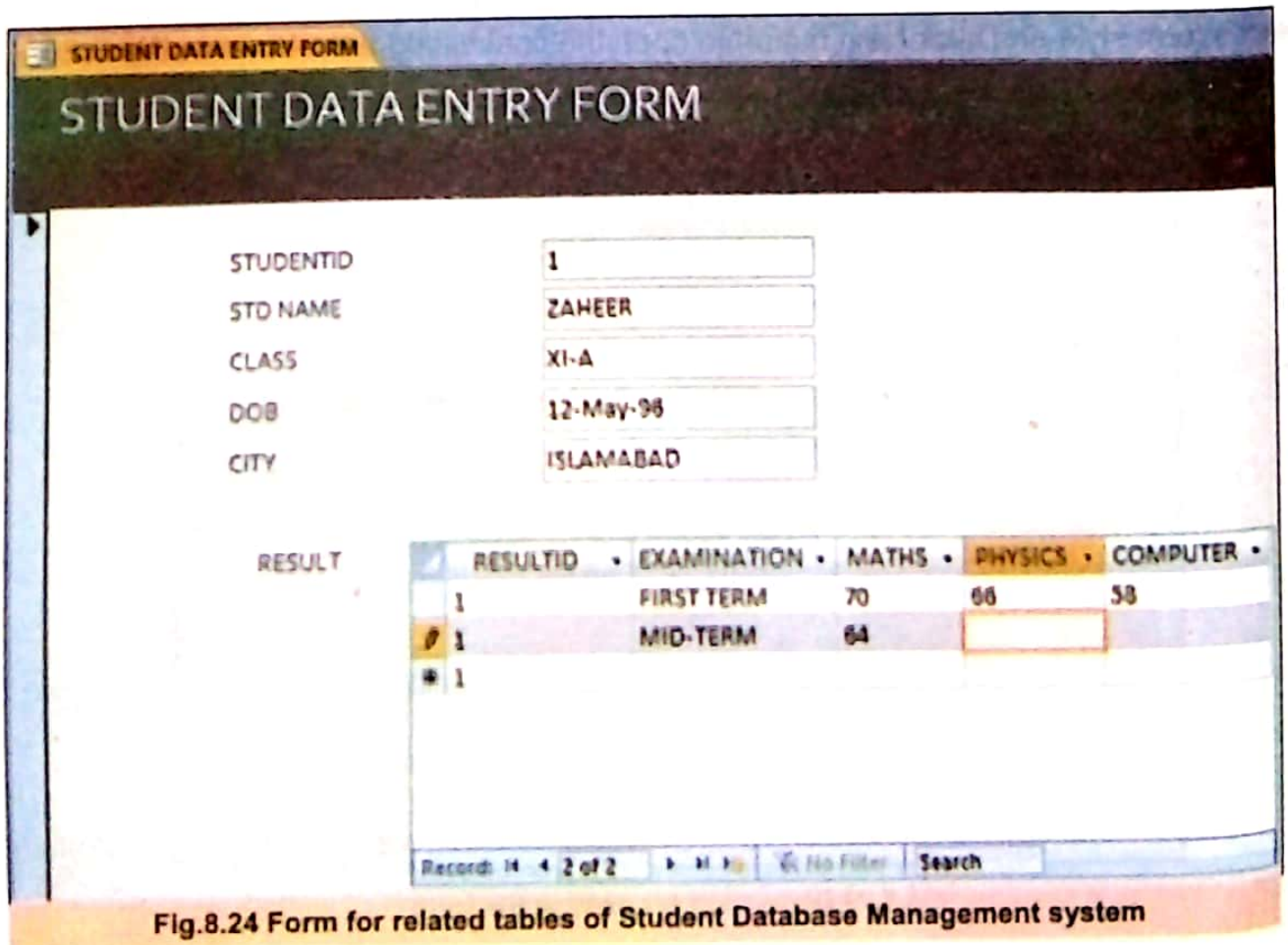


Fig.8.24 Form for related tables of Student Database Management system

3. Move all the fields of STUDENT table from the Available Fields list to the Selected Fields list using the buttons.
4. In the same dialog box, select the RESULT table also and move all the fields to the Selected Fields list to see them in the subform and click the Next button.
5. The wizard will ask you how you want to view your data. Select by STUDENT and also select Form with subform(s) which is the default choice and click the Next button.
6. Select the Datasheet layout for your subform and click the Next button.
7. Select a style that you like and click the Next button.
8. Type the title STUDENT DATA ENTRY FORM for the form and RESULT for the subform and click Finish button to save it.

8.3.2 DIFFERENT FORM VIEWS

There are three basic types of forms depending on the layout. These are columnar, tabular and datasheet forms. We select the type of form in the Form Wizard dialog box when we specify the layout as shown in Fig.8.25. When we select the form type in the dialog box, the window on the left shows its layout.

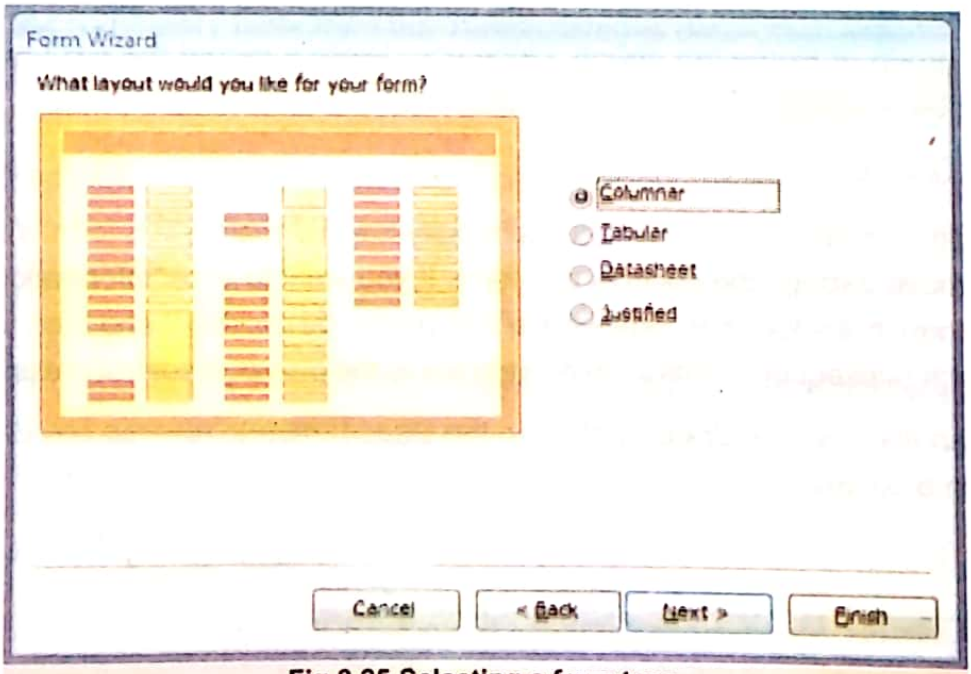


Fig.8.25 Selecting a form type.

8.3.3 NAVIGATING THROUGH RECORDS IN A FORM

A small toolbar is permanently placed in the lower left corner of the form window as shown in Fig.8.26. This toolbar will help you to navigate through the existing records or to add new records. To view a specific record, click the empty box in the centre of the toolbar in the bottom left corner and type the record number and press Enter. You can also use the Find option in the ribbon of Home tab to go to a record that contains specific text in one of its fields.

8.3.4 USING FORM TO ADD, MODIFY AND DELETE RECORDS

Adding new record

To create a new record, click the New Record button that contains the asterisk on the toolbar at the bottom of the form window or click the New Record button in the Records group of Home tab. The new record will be added to the end of the table and will be displayed in the form window so that you can enter information into it.

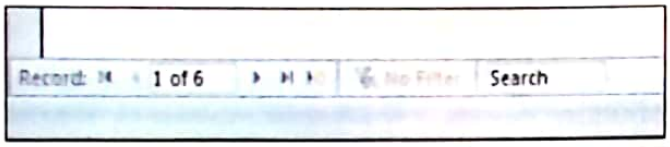


Fig.8.26 Toolbar for navigating through records

Modifying record

To modify data of a record in a form, first display that record on the screen using the navigation toolbar and then just click the text box control and enter the new data. As soon as you leave that record data is automatically saved.

Deleting record

To delete a record, first display it in the form window and then choose Delete Record from the Records group of Home tab ribbon. Once you delete a record the data is permanently lost and it cannot be restored using the Undo command.

8.3.5 USING FORM CONTROLS

You can click any text box control and modify the information in a form. You can use Tab or Enter key to move through the controls in a form. If you want to enter information into the text box controls of a form in a sequence, activate the first control by clicking it and then press Tab or Enter to move to each subsequent control. To move back to the previous control press Shift+Tab.

You can also use the Undo by clicking the Undo button to reverse any changes you made to the value in a control.

8.4 WORKING WITH QUERIES AND COMMANDS

8.4.1 DIFFERENT WAYS OF CREATING, SAVING AND EDITING QUERIES

You can create a large variety of queries in Access. You will learn the basics of creating queries using Query Wizard and Query Design. These two methods for creating queries are given in the other group of Create tab of Access ribbon.

8.4.2 CREATING QUERIES

Creating a query using Query Wizard

We are going to create a query that will display the STUDENTID, STD NAME and CLASS fields of STUDENT table. The following are the steps to create this query.

1. Click the Create tab.
2. Click Query Wizard in the Other group and select Simple Query Wizard from New Query window shown in Fig.8.27.

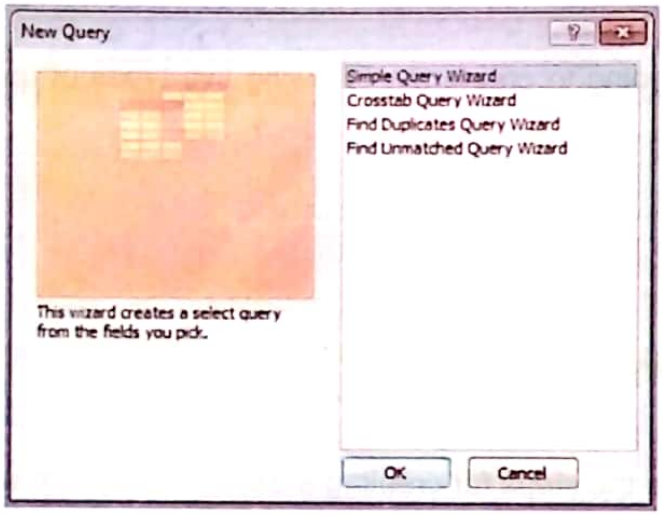


Fig.8.27 New Query window

3. Select the STUDENT table from the Tables/Queries drop-down list.
4. Move the fields STUDENTID, STD NAME and CLASS from the Available Fields list shown in Fig.8.28, to the Selected Fields list and click Next.
5. Enter the title STUDENT NAME AND CLASS for the query and click Finish.

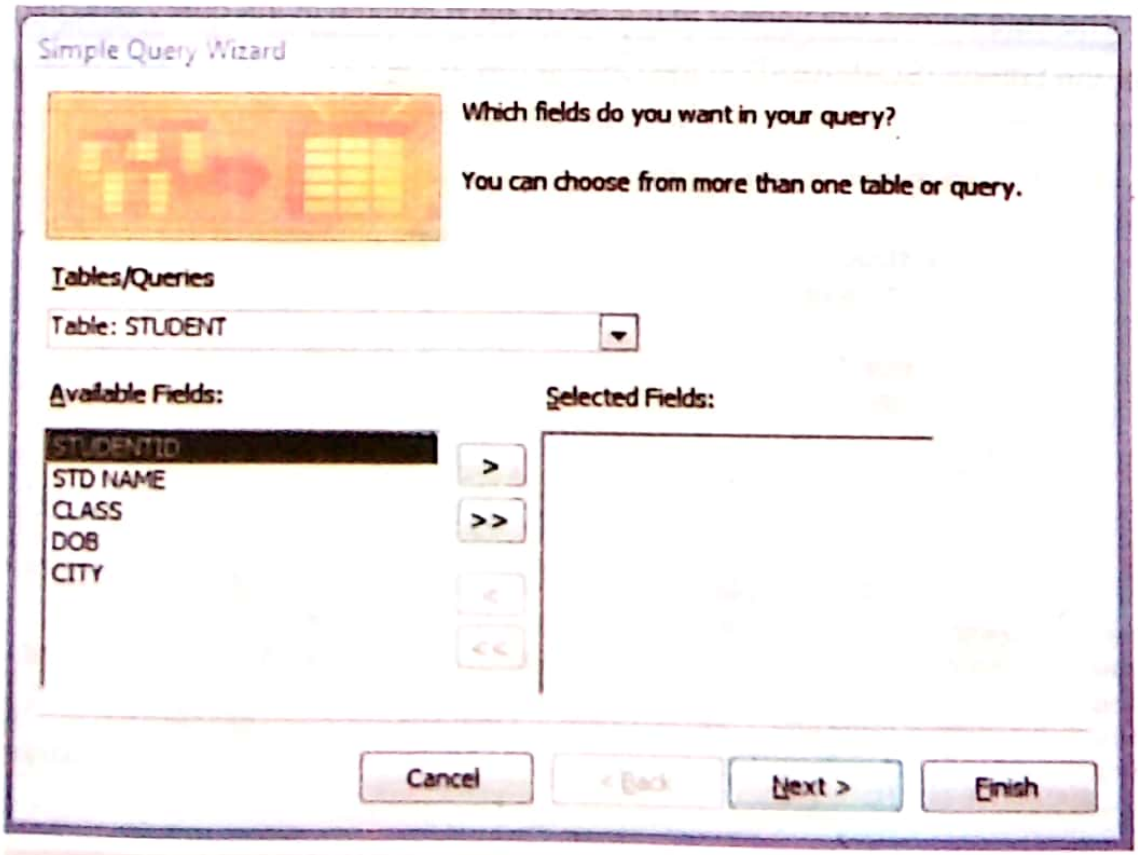


Fig.8.28 Selecting fields in Simple Query Wizard

6. The fields that you have selected will be displayed in datasheet view.
7. Close the query when you have finished. Access will automatically save the query so that you can reopen it later.

Creating Queries using Query Design

In this section we are going to create the following five types of queries which are commonly used in databases.

- Select Query
- Update Query
- Delete Query
- Append Query
- Make Table Query

Creating a Select Query

The following are the steps for creating a Select Query that will display all the records of STUDENT table in which the CITY field is ISLAMABAD.

1. Click the Create tab.
2. Click the Query Design icon in the Other group to bring up the query design window.
3. Add the STUDENT table and close the Show Table window.
4. Double click all the fields one by one in the box labeled STUDENT above the query design grid. The field names will appear at the top of each column in the query design grid.
5. Enter the criteria ISLAMABAD in the Criteria row in the CITY column as shown in Fig.8.29.

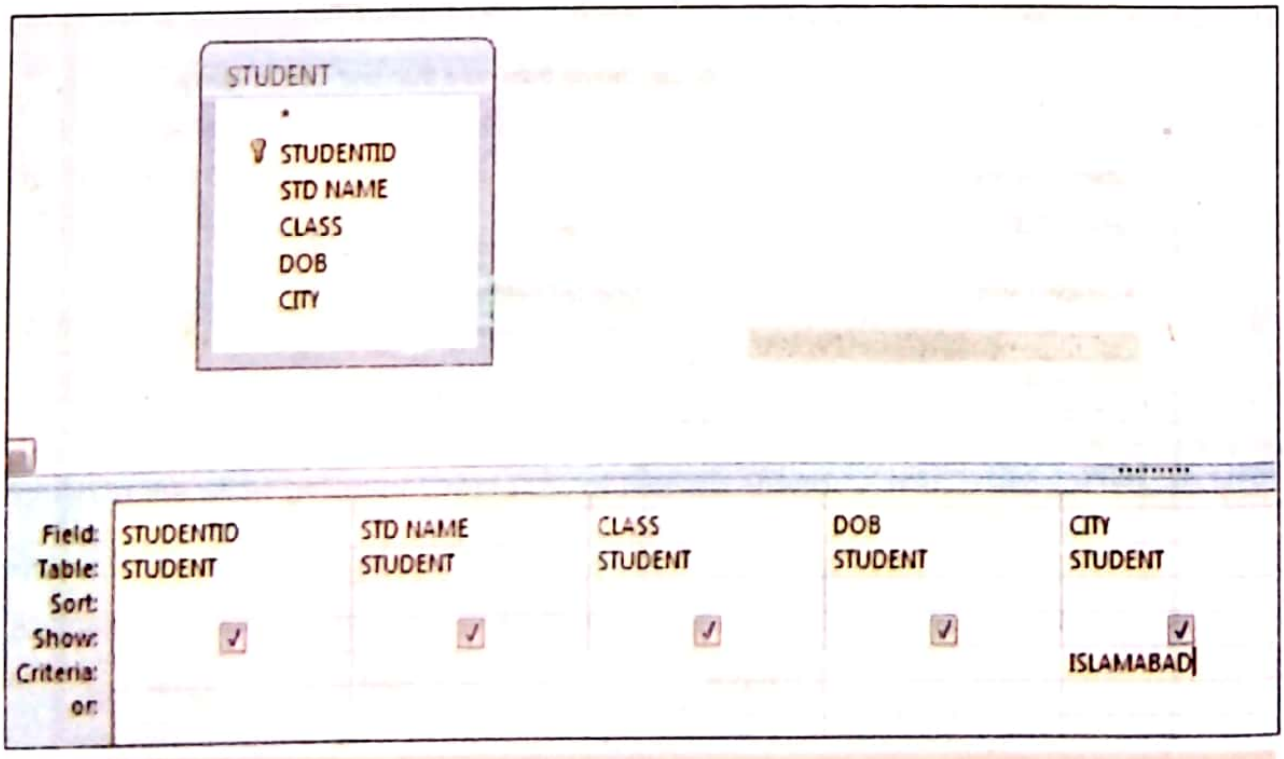


Fig.8.29

6. Click the Save icon above the Access ribbon to save the query. When you are prompted for the query name, enter STUDENTS LIVING IN ISLAMABAD and click OK.
7. To run the query, click the query name in the Navigation Pane on the left side of the screen. You will see a datasheet displaying records of all the students who live in Islamabad as shown in Fig.8.30. You can also run the query without saving it. After creating the select query, click Run in the Results group of Design tab on Access Ribbon.

Students Living in Islamabad

STUDENTID	STD NAME	CLASS	DOB	CITY
	ZAHEER	XI-A	12-May-96	ISLAMABAD
3	JAVED	XI-A	01-Mar-96	ISLAMABAD
6	ZEESHAN	XI-B	28-Dec-95	ISLAMABAD
*	(New)			

Fig.8.30 List of students living in Islamabad

Creating an Update Query

Update queries are used to change, add or delete data in existing records. You cannot use an update query to add records to or delete records from a table but you use it to change existing null values to non-null values and non-null values to null values.

We are going to create an update query that will update the CITY field of all the records that have the data ISLAMABAD in the STUDENT table to LAHORE. The easiest way to create an update query is to first create a select query and then convert it into an update query.

The following are the steps to create update query.

1. First create the select query with the criteria ISLAMABAD in the CITY column.
2. On the Design tab in the Query Type group as shown in Fig.8.31 click Update.

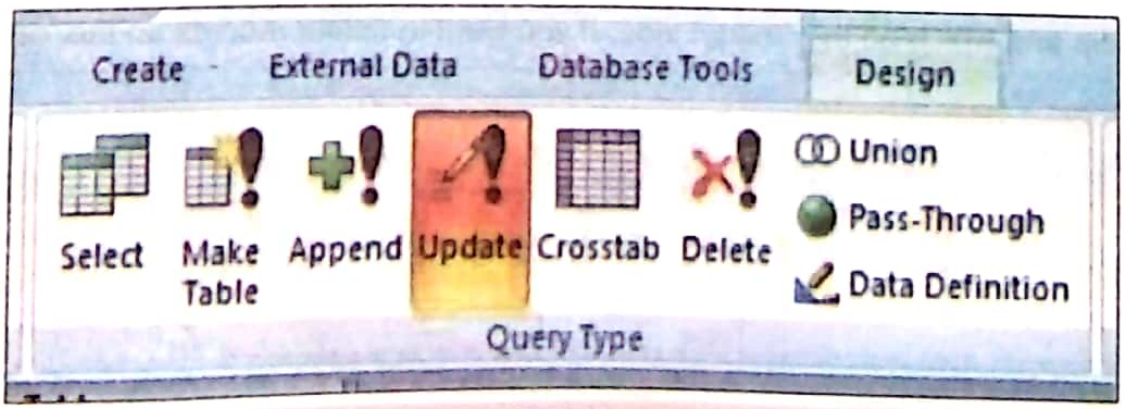


Fig.8.31

3. Access will add the Update To row in the query design grid as shown in Fig.8.32. Type LAHORE in the CITY column in the Update To row.
4. Click the Save icon on the top left corner of the screen.
5. Type a name for the query and click OK.
6. Double click the query in the Navigation Pane to see the result.

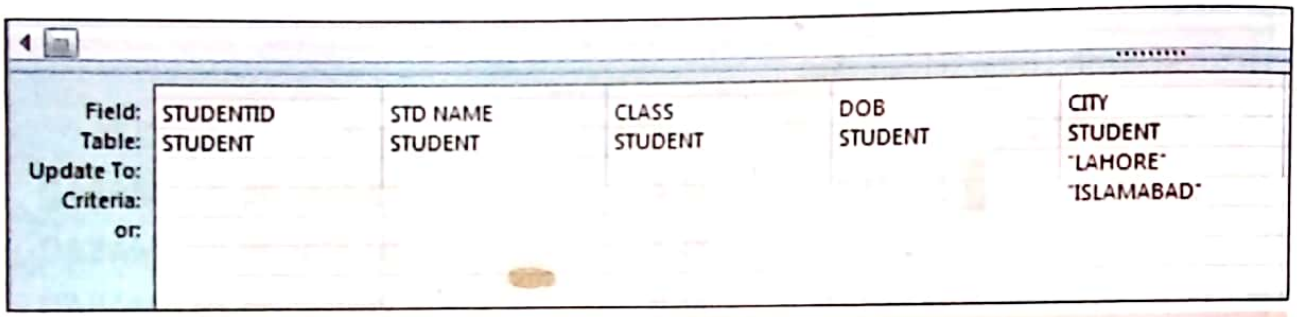


Fig. 8.32 Query Design grid for creating Update Query

Creating a Delete Query

Delete queries are used to delete entire records from tables along with the primary key. The process of creating a delete query using query design window is very similar to creating update query. To do this, first create a select query to select the records that you want to delete and then convert it into a delete query.

Suppose in our Student Database Management System we want to delete records of all the students of class XI-B.

The following are the steps to create this query.

1. First create the select query with the criteria XI-B in the CITY column.
2. On the Design tab in the Query Type group shown in Fig.8.33, click Delete. This will hide the Show row in the lower section of the design grid and add the Delete row.
3. To delete the selected records, click Run in the Results group of Design tab. Access will ask you to confirm your action, click Yes to confirm.

To delete related data in tables, determine which records are on the "one" side of the relationship and which on the "many" side. If you want to delete records on the "one" side of the

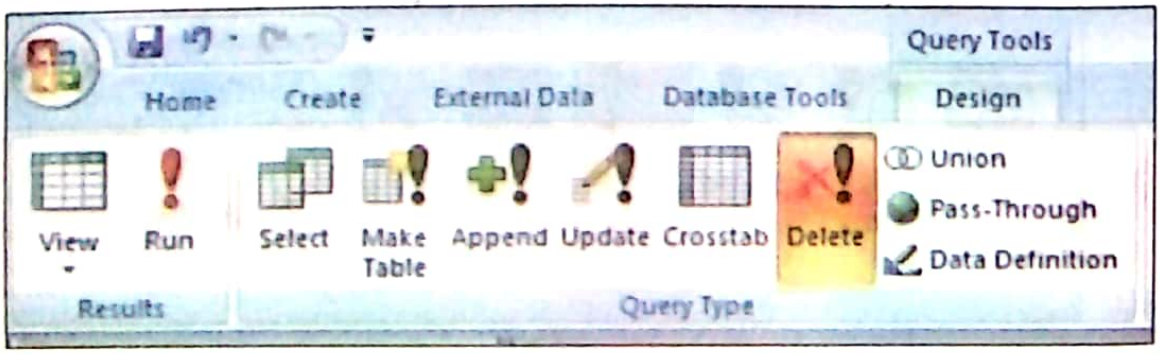


Fig.8.33 Creating a delete query

relationship and the records on the "many" side, you must enable Referential Integrity and cascading delete. If you need to delete records only on the "one" side of the relationship, you first delete that relationship and then delete the data. If you need to delete records only on the many side of the relationship, you can create and run your delete query without having to change the relationship.

Creating an Append Query

Append query is used to add records from a more source table to a destination table. Very often, the source and destination tables are in the same database. Append queries are not used to change the data in individual fields in existing tables. For this we use update query. When appending records in table, make sure that the data types you set for the fields in the source table are compatible with the data types that you set for the table fields in the destination table.

An easy way to create an append query is first create the select query and then convert it into an append query as we did for creating an update and delete query.

1. The following are the steps to create an append query to append records of students of any section of class XII to a table in another database.
2. Open the database that contains the records that you want to append.
3. Click the Create tab and click Query Design to bring up the query design window.
4. Select the table that contains the records that you want to append and click Add and then click Close.
5. Double click the fields that you want to append so that they appear in the Field row on the design grid.
6. Enter the criteria Like "XII-?" in CLASS column as shown in Fig.8.34 The criteria will find all the records that contain a 5 letter string in which the first 4 letters are "XII-" and the last letter is unknown for any section of class XII.

Field:	STUDENTID	STUDENT NAME	CLASS	DOB
Table:	STUDENT	STUDENT	STUDENT	STUDENT
Sort:				
Show:	☑	☑	☑	☑
Criteria:			Like "XII-?"	
or:				

Fig.8.34 Query design grid showing append criteria

7. Click Append in the Query Type group of Design tab shown in Fig.8.35.

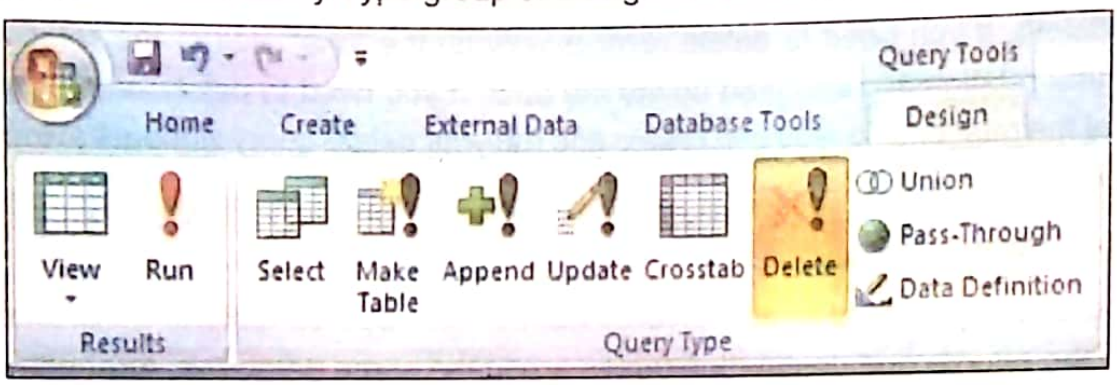


Fig.8.35 Selecting query type from Design tab

8. The Append dialog box shown in Fig.8.36 will appear. Enter the table name in which you want to append the records. Choose to append records to another database and enter the file name and then click the OK button.

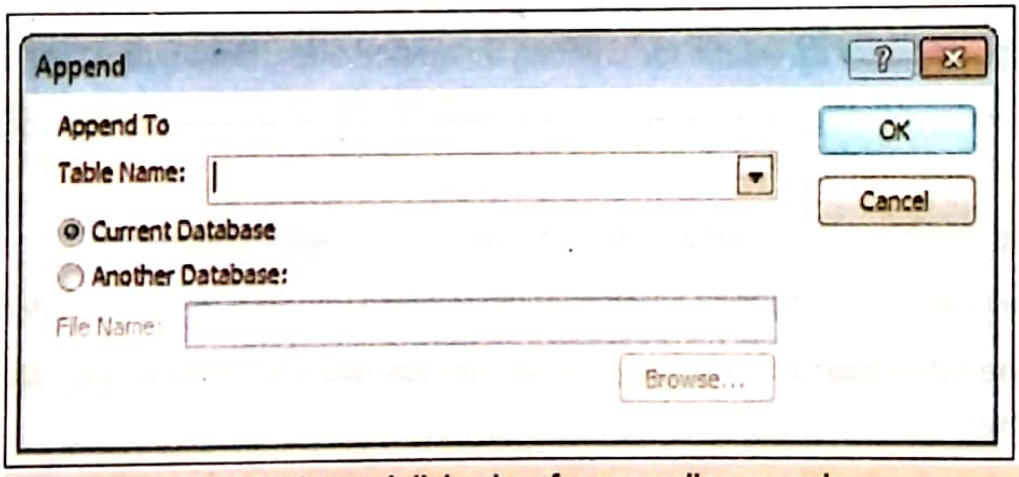


Fig.8.36 Append dialog box for appending records.

Creating a Make Table Query

A make table query retrieves records from a table and copies them into a new table. The new table can be in the database that you have open or you can create it in another database. To create a make table query, first create a select query and then convert it into a make table query. Choose a location for the new table and then run the query to create the new table.

The following are the steps to copy all the records of students having the data ISLAMABAD in the CITY column of STUDENT table.

1. First create a select query that has the criteria ISLAMABAD in the CITY field column in the query design grid.

2. Click Make Table in the Query Type group of Design tab. The Make Table dialog box will appear as shown in Fig.8.37.
3. If you want to place the new table in the current database, select Current Database otherwise select Another Database and enter the location and the file name of the other database.
4. Click OK.
5. Click Run in the Results group of Design tab.

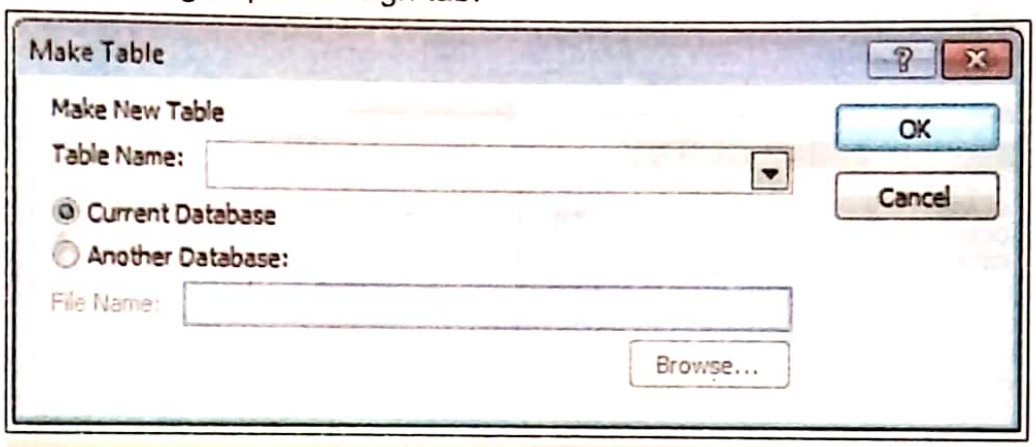


Fig.8.37 Make Table dialog box

8.5 GENERATING REPORTS

The final product of most database applications is a report. Access combines data in tables and queries to produce a report that you can print and distribute to people who need or request it. Reports provide means for creating printed copies of the information in your database. Some reports consist of a single page, such as, order acknowledgement and invoice. Multi-page Access reports are more common than the single-page reports. These reports include catalogs, general ledgers, financial statements and examination result sheets.

8.5.1 CREATING A SIMPLE REPORT USING REPORT WIZARD

We are going to create a simple report that will display all the fields of STUDENT table in ascending order by name and having portrait orientation.

Following are the steps to create the report.

1. Click the Create tab in the Access ribbon
2. Click Report Wizard icon in the Reports group shown in Fig.8.38.

Fig.8.38 Running Report Wizard from Reports group

3. Select STUDENT table in the Tables/Queries drop-down list.
4. Move all the fields from Available Fields list shown in Fig.8.39 to the Selected Fields list.

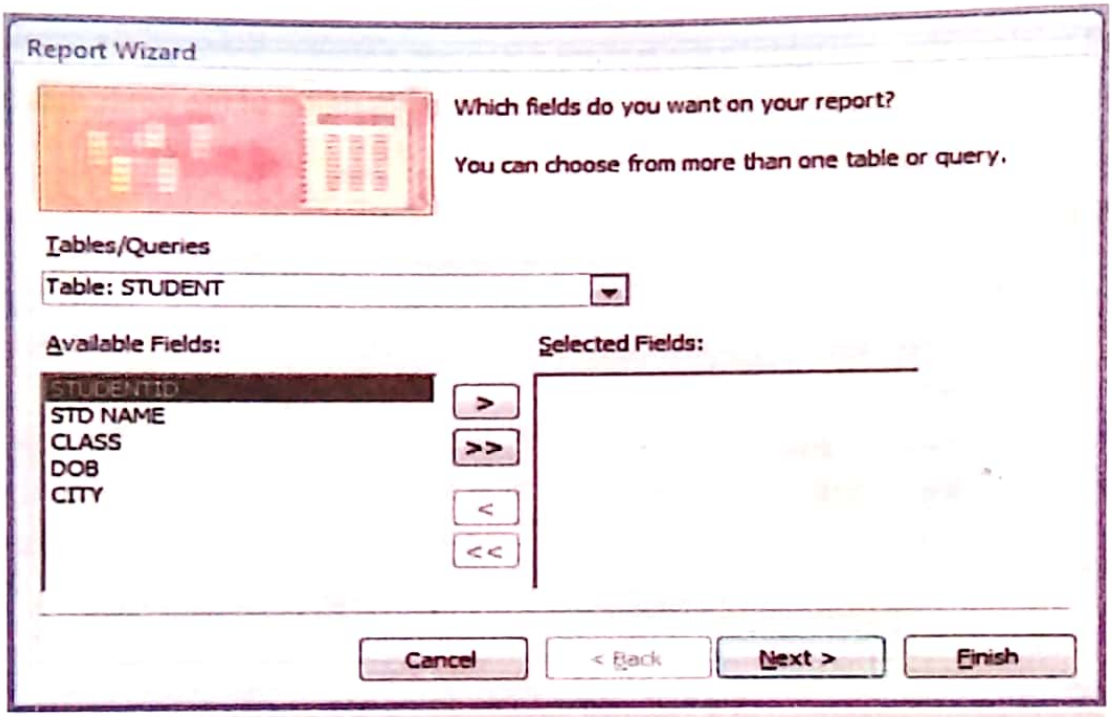


Fig.8.39 First screen of Report Wizard

5. Click Next.
6. Click Next again.
7. Select STD NAME to sort the report by student name and select ascending order by clicking the button on the right side as shown in Fig.8.40.

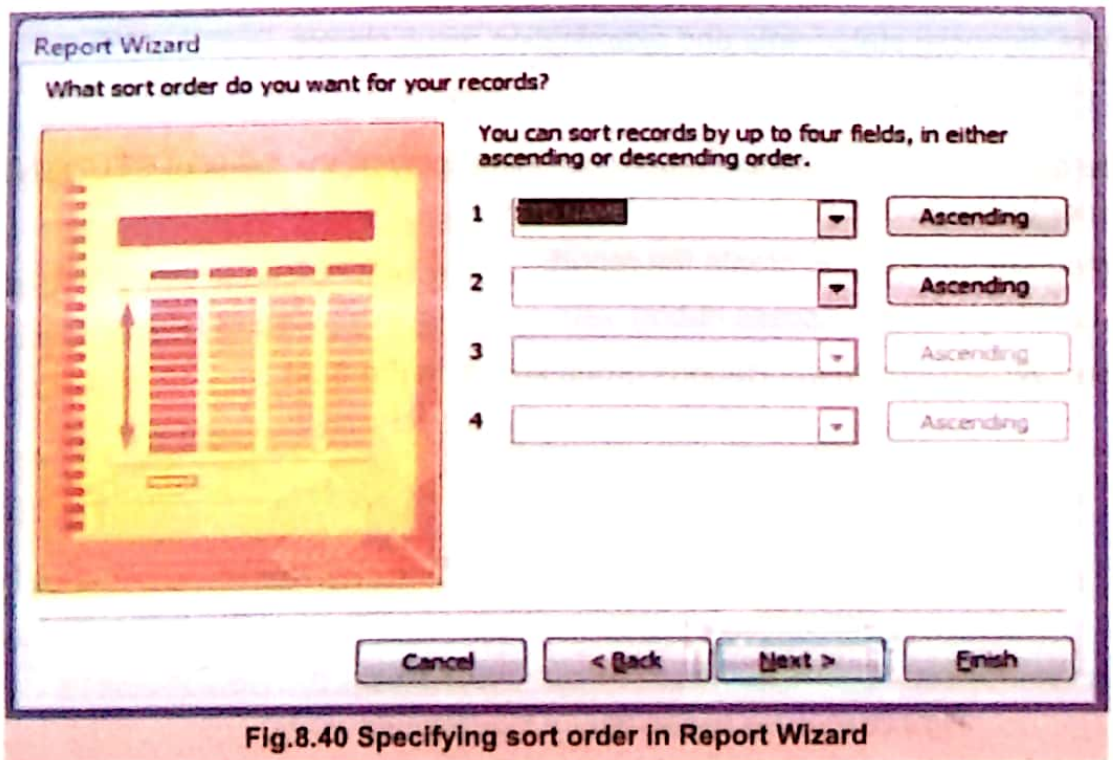


Fig.8.40 Specifying sort order in Report Wizard

Access allows to sort records up to four fields and you can select Ascending or Descending order for these fields.

8. Click Next.
9. Select Tabular layout and Portrait orientation for the report as shown in Fig.8.41 and click Next.

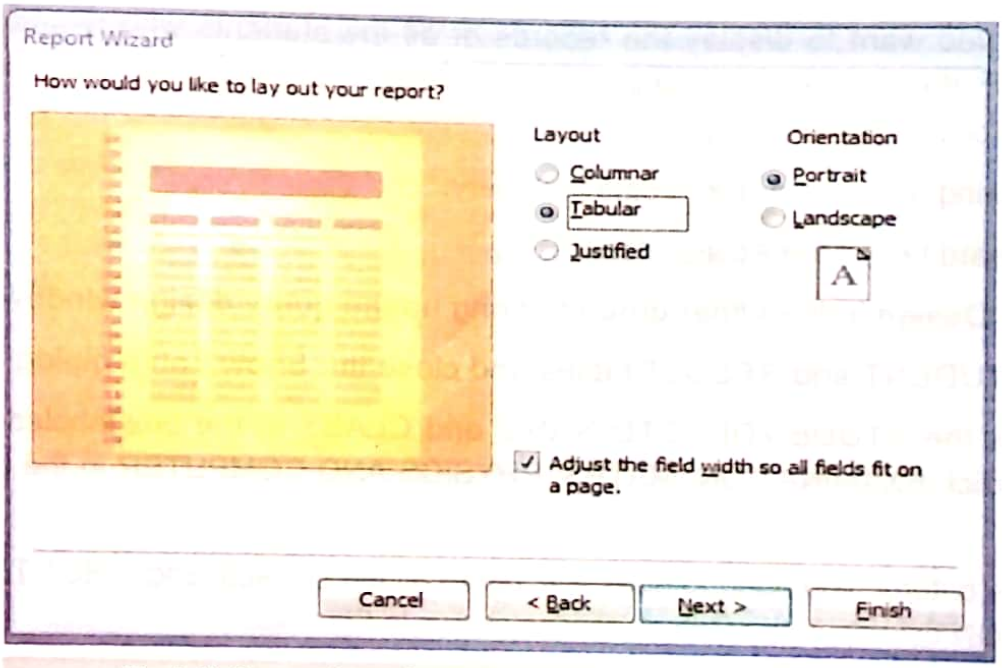


Fig.8.41 Screen for selecting report layout and orientation

Select a report style from the list shown in Fig.8.42 and click Next.

10. Enter a title for the report and click Finish.

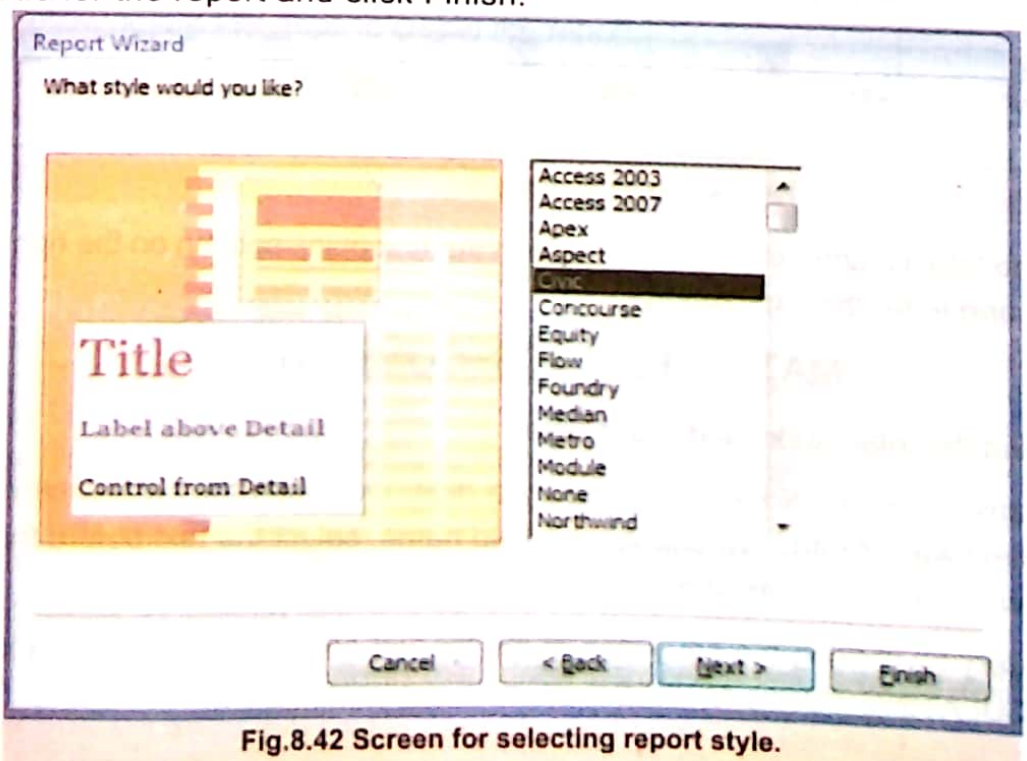


Fig.8.42 Screen for selecting report style.

8.5.2 CREATING A REPORT USING A QUERY

Generally, database users use reports to display the results of a query, which is what we are going to do. Earlier in this unit we created relationship between the STUDENT table and the RESULT table in the Student Database Management System. These tables are having one-to-many relationship because a student has many examinations throughout the year. Suppose you want to display the records of all the students who passed in all the three subjects in the First Term Examination and their total marks. First we are going to create a query for this report.

The following are the steps to create the query.

1. Click the Create tab on the Access ribbon.
2. Click Query Design in the Other group to bring up the query design window.
3. Add both STUDENT and RESULT tables and close the Show Table dialog box.
4. Double click the STUDENTID, STD NAME and CLASS in the box labeled STUDENT and double click EXAMINATION, MATHS, PHYSICS AND COMPUTER in the box labeled RESULT.
5. To set up the criteria, you need to enter >32 below all the subjects and FIRST TERM below EXAMINATION column in the Criteria row as shown in Fig.8.43.

EXAMINATION RESULT	MATHS RESULT	PHYSICS RESULT	COMPUTER RESULT	TOTAL: [MATHS]+[PHY
☑	☑	☑	☑	☑
"FIRST TERM"	>32	>32	>32	

Fig.8.43 Creating query for calculated field

6. To create the total column, click the Field row in the first blank column on the right side of the design grid and enter the expression

MATHS+PHYSICS+COMPUTER

for calculating the total marks and press enter.

7. The field name consists of Expr followed by a digit, indicating the sequence in which the calculated field was created. To change the field name, select the text before the colon and type the new name TOTAL as shown in Fig.8..
8. Save the query by clicking the save icon at the top left corner of the screen and give it the name CALCULATING TOTAL MARKS.

When you run this query from the Navigation Pane you will see the datasheet that displays records of all the students who have passed in all the three subjects along with the total marks as shown in Fig.8.44.

STUDENT DATABASE : Database (Access 2007) - Microsoft Access

al Data Database Tools

CALCULATING TOTAL MARKS | CALCULATING TOTAL MARKS

STUDENTID	STD NAME	CLASS	EXAMINATIC	MATHS	PHYSICS	COMPUTER	TOTAL
1	ZAHEER	XI-A	FIRST TERM	70	66	58	194
2	MANSOOR	XI-B	FIRST TERM	78	83	69	230
4	KHURRAM	XI-A	FIRST TERM	87	92	90	269
6	ZEESHAN	XI-B	FIRST TERM	78	63	85	226
*	(New)						

Fig.8.44 Datasheet view of query that displays results of students who have passed in all the three subjects along with the total marks

Now, we are going to use this query to create the report that will print the records of all the students who have passed in all three subject along with the total marks.

The Following are the steps to create the report.

1. Click the Create tab on the Access ribbon and click Report Wizard in the Reports group.
2. Select the query CALCULATING TOTAL MARKS from the drop-down list of Tables/Queries as shown in Fig.8.45.
3. Move all the fields of query from the Available Fields list to the Selected Fields list using the buttons and click Next.

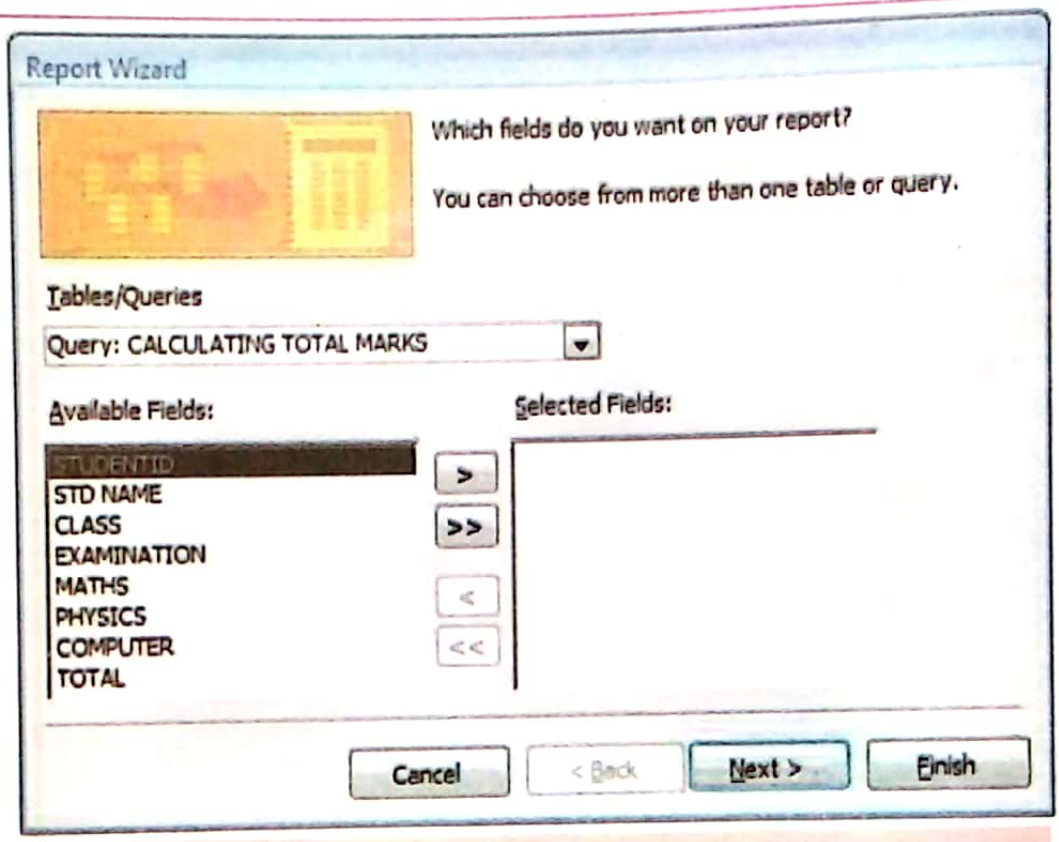


Fig.8.45: Selecting query in Report Wizard

4. Click the Next button to accept the default for viewing the data.
5. Click the Next button to accept the default grouping level.

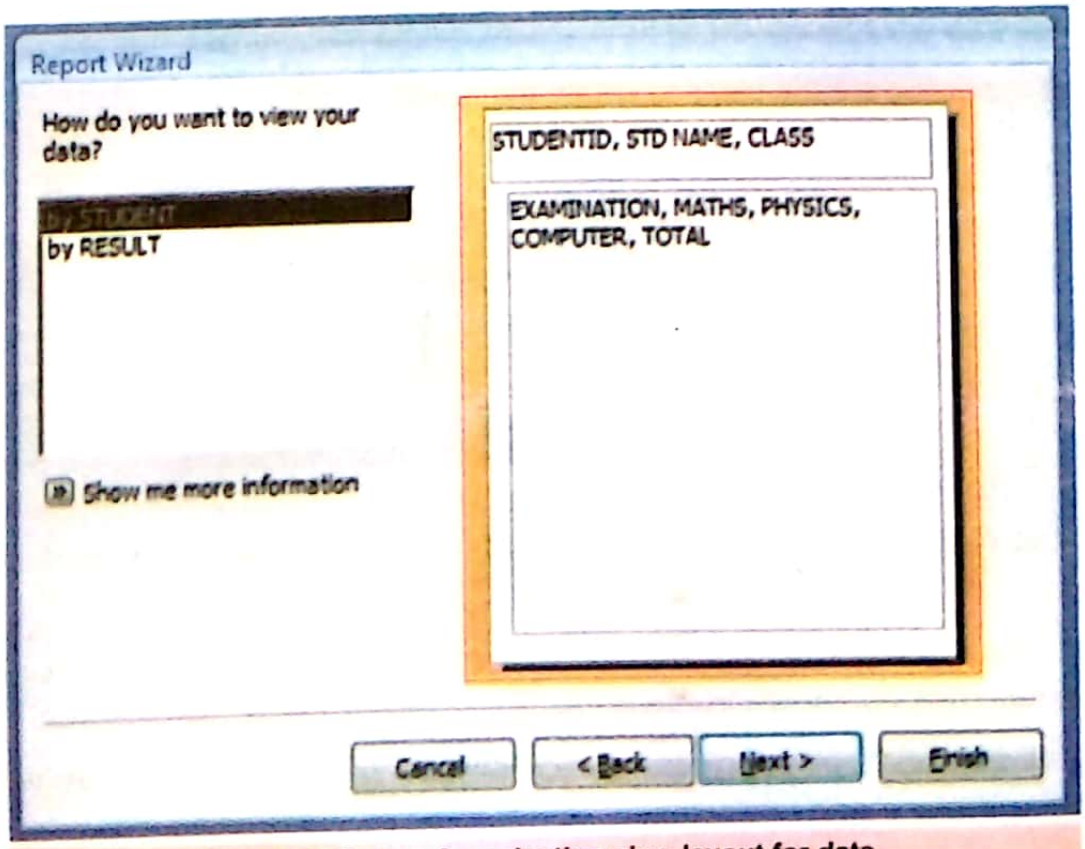


Fig.8.46: Screen for selecting view layout for data

6. Click the Next button to accept the default for report layout.

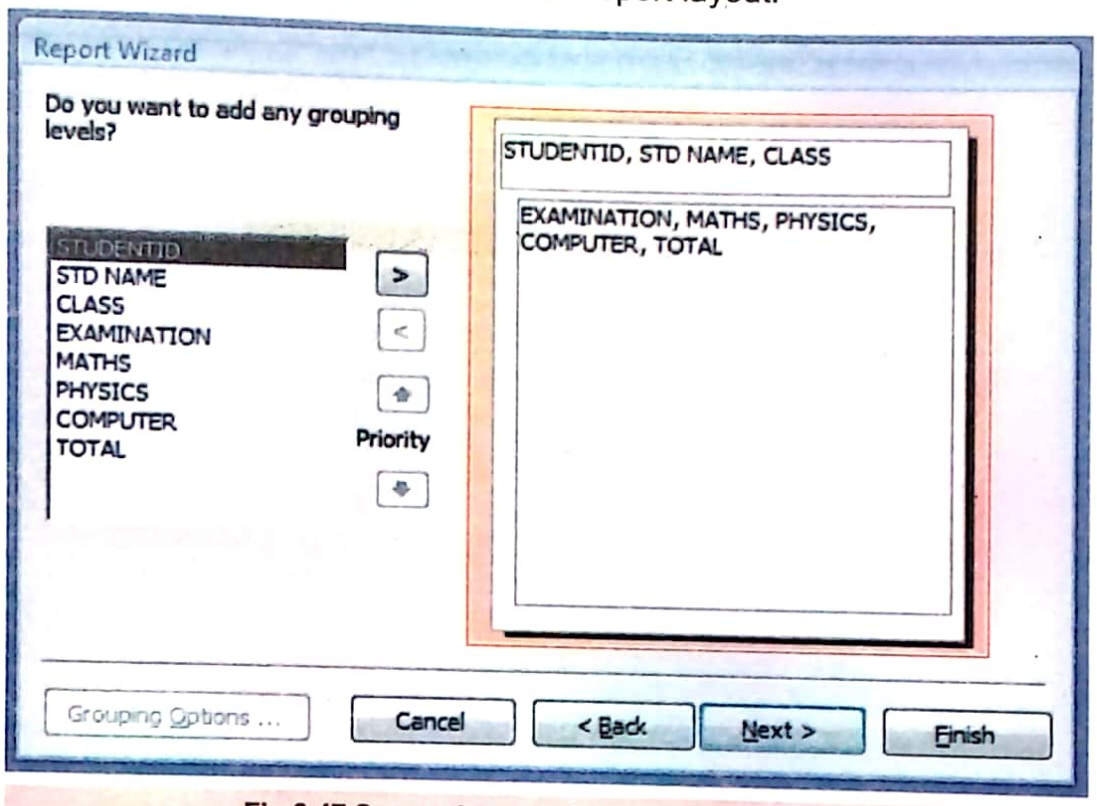


Fig.8.47 Screen for specifying grouping levels

7. Select the Aspect style for the report and click Next.

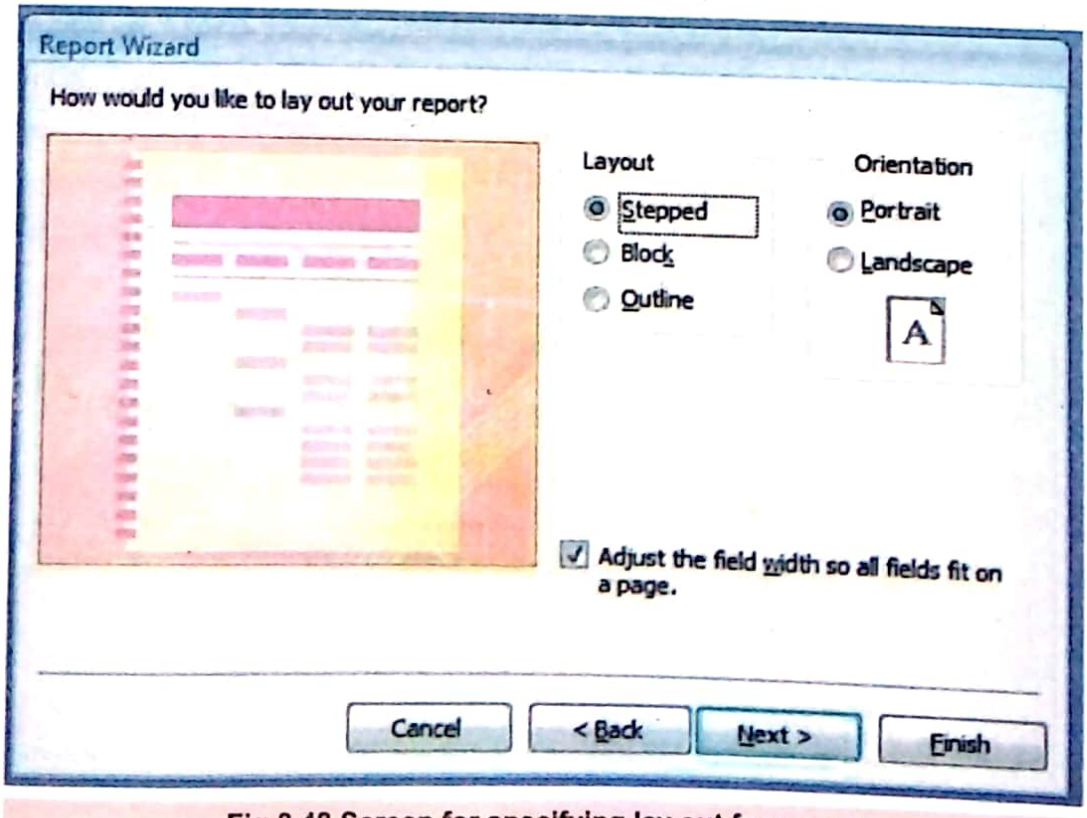


Fig.8.48 Screen for specifying lay out for report

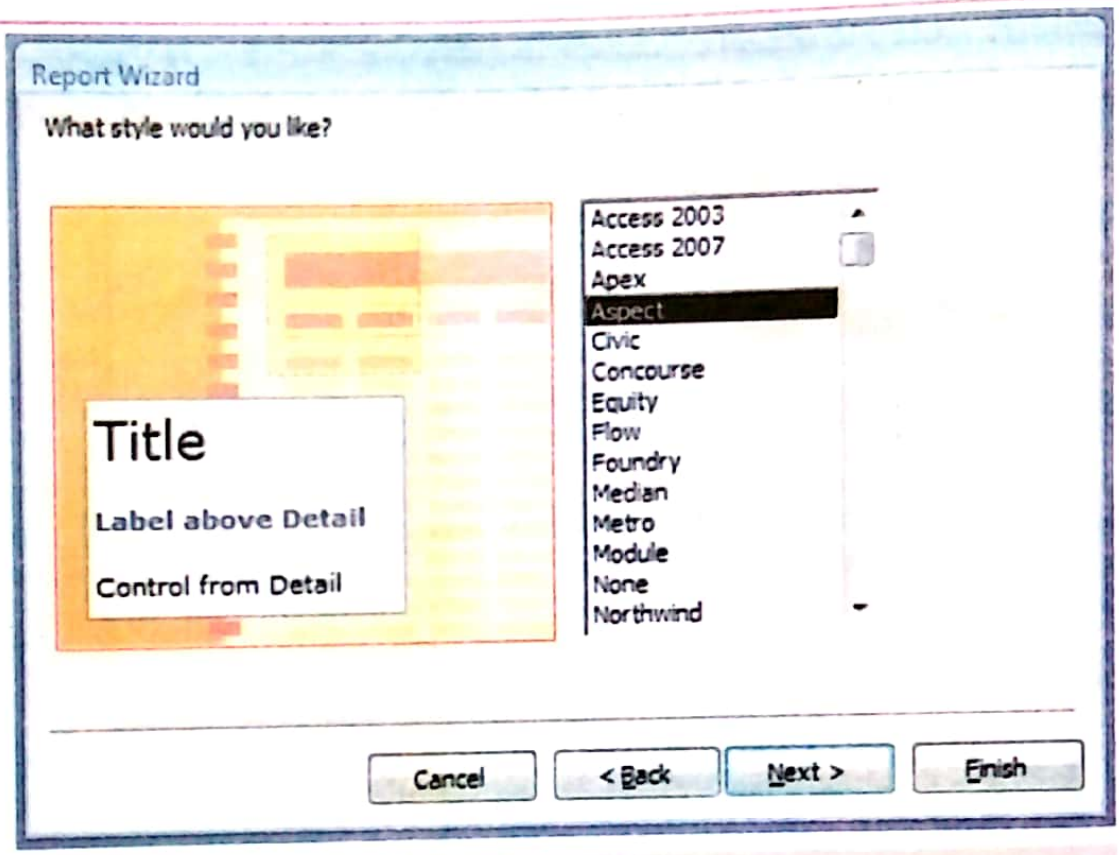


Fig.8.49 Screen for selecting report style

8. Give your report the title CALCULATION OF TOTAL MARKS and click Finish as shown in Fig.8.50.

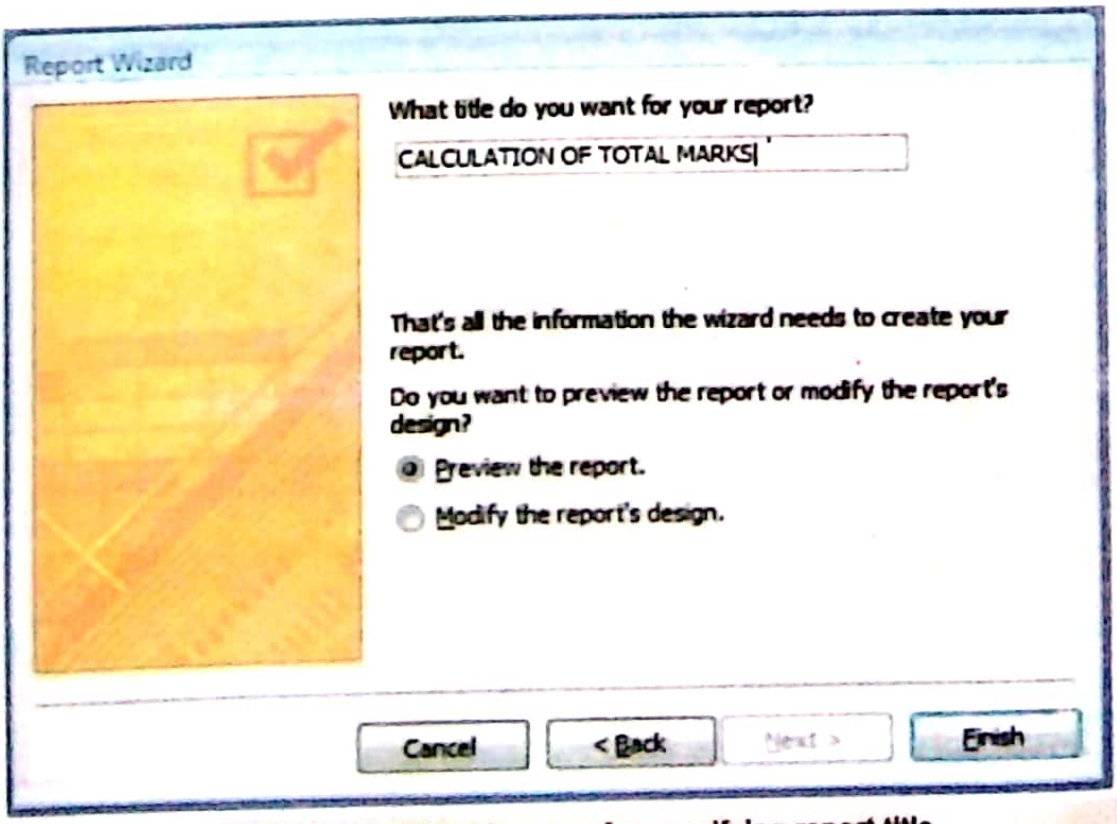


Fig.8.50 Report Wizard screen for specifying report title

After clicking the Finish button, the report will be displayed on the screen as shown in Fig.8.51.

CALCULATION OF TOTAL MARKS

STUDENTID	STD NAME	CLASS	EXAMINATION	MATHS	PHYSICS	COMPUTER	TOTAL
1	ZAHEER	XI-A					
			FIRST TERM	70	66	58	194
2	MANSOOR	XI-B					
			FIRST TERM	78	83	69	230
4	KHURRAM	XI-A					
			FIRST TERM	87	92	90	269
6	ZEESHAN	XI-B					
			FIRST TERM	78	63	85	226

Fig.8.51 Report of students who passed in all three subjects along with their total marks

8.5.3 VIEWING AND PRINTING REPORT

Viewing a Report

When you create any database object, it is displayed in the Navigation Pane on the left side of the screen. To view the report, you just have to double click it.

Printing a Report

The following are the steps for printing a report.

1. Open the report that you want to print from the Access Navigation Pane by double clicking it.
2. Click the Microsoft Office button and then click Print. Keyboard shortcut for this command is Ctrl + P.
3. Specify the Print dialog box options and click Print to print your report.

Teacher Point

Teacher should give some home assignments to the students at the end of the chapter.

If you want to quickly print all the pages in the report without using the Print dialog box, right click the report in the Navigation Pane and click Print. Access will print the entire report by using the margins, headers, footers and orientation (portrait or landscape) specified for the report. You cannot change any of these properties when you use this option.

Formatting Reports and Forms

Reports and forms are used to display information contained in your database and both use the same technique and tools to format their controls. These techniques include methods for moving and aligning the various controls, for changing the font style and for changing the color, border and shading effects for different elements. To work with controls of a report or form, double click the report or form in the Navigation Pan. After opening the report or form, click the View option in the Home tab ribbon and select Design View. Now you can move any control to different position, change font size, style, color or change background of a control, etc.

Key Points

- Microsoft Office Access 2007 is a member of Microsoft Office 2007 integrated software and it is the most popular software used worldwide for developing and managing databases.
- It provides tool for creating tables, forms, queries and reports that make up a database.
- In Access all the information of a database in stored in tables since it is a relational database management system.
- Seven types of data types are generally used in Access which are text, memo, number, autonumber, yes/no, currency and date/time.
- Sorting feature of Access allow to alphabetically or numerically sort the records in a table in ascending or descending order.
- A form is a tool that makes it easy to enter, delete, modify and view the information stored in one or more tables in a database. It presents data in an organized and attractive manner.
- Query is a tool that answers questions about data to select specific information from tables and to change selected data in various ways. It lets you see the data you want and in the order you want it.

- Report is a database object that organizes and formats data stored in tables or queries to make it presentable and meaningful to other people. Reports are used to print data stored in tables and queries which is an essential part of using a database.
- Columnar report displays each field of a record on a separate line with a label to its left. It spreads the information for a single record over many rows.
- Tabular reports display fields of records in a horizontal row with field labels at the top of the report.

Exercise

Q1. Select the best answer for the following MCQs.

i. Which of the following is used to gather information based on one or more criteria?
   A. Table B. Form
   C. Query D. Report

ii. Which data field type is used to provide descriptive comments?
   A. Text B. Memo
   C. Autonumber D. Yes/No

iii. Selecting records in a table which match a given criteria is known as:
   A. Sorting data B. Searching data
   C. Updating data D. Filtering data

iv. The maximum number of records in a table that can use the Autonumber field is slightly more than:
   A. 1 Million B. 1 Billion
   C. 2 Billion D. 3 Billion

v. Which database object stores all the information of a database?
   A. Table B. Form
   C. Query D. Report

vi. What is the default value of number of characters for Text data type in Access?
   A. 30 B. 40
   C. 50 D. 60

vii. Which query is used to add records from a table to another table?
   A. Select query B. Update query
   C. Append query D. Make Table query

viii. Which query is used to change data in existing records?
   A. Select query B. Update query
   C. Append query D. Make Table query

ix. In which tab of Access ribbon Relationships icon is located?

A. Home
B. Create
C. External Data
D. Database Tools

x. In which tab of Access ribbon Query Design icon is located?

A. Home
B. Create
C. External Data
D. Database Tools

Q2. Give short answers of the following questions.

i. Which tasks can be performed using Microsoft Office Button?
ii. Describe various ways of deleting records in a table.
iii. What are the advantages of using forms?
iv. What is meant by referential integrity?
v. Describe how records can be added and deleted using forms.
vi. Describe columnar, tabular and datasheet layouts of forms.
vii. What is the use of Query Design grid?
viii. What is OpenOffice Base?
ix. Differentiate between update and append query.
x. Differentiate between columnar and tabular reports.

Q3. Give long answers of the following questions.

i. Explain the following database objects.
   - Tables
   - Forms
   - Queries
   - Reports
ii. Explain the field data types used in Access.
iii. Describe how forms are created.
iv. Write the steps for creating relationships between tables.
v. Describe the types of queries that can be created in Access.

Lab Activities

Following lab activities are to be carried out during the practical periods.

1. Students should know how to launch Access and create and save a database.
2. Creation of following database objects should be demonstrated on the computer.
   - Table
   - Form
   - Query
   - Report
3. Following operations should be performed on the computer.
   - Entering, deleting and modifying of data in records
   - Filtering records
   - Sorting records
   - Searching records
4. Creating and editing relationships between tables.
5. Formatting and printing Forms and Reports.
6. Run different Queries and Reports to extract desired information.
7. Prepare Address book using Access. Run different queries and reports to extract desired information.

Answers to MCQs

UNIT 1

Q1. Select the best answer for the following MCQs.

i. (C)	ii. (C)	iii. (B)	iv. (C)	v. (A)
vi.(D)	vii.(A)	viii.(B)	ix. (C)	x. (A)

UNIT 2

Q1. Select the best answer for the following MCQs.

i. (C)	ii. (C)	iii. (A)	iv. (B)	v. (C)
vi.(B)	vii.(D)	viii.(A)	ix. (C)	x. (D)

UNIT 3

Q1. Select the best answer for the following MCQs.

i. (B)	ii. (D)	iii. (C)	iv. (A)	v. (C)
vi.(B)	vii.(A)	viii.(D)	ix. (C)	x. (D)

UNIT 4

Q1. Select the best answer for the following MCQs.

i. (A)	ii. (D)	iii. (D)	iv. (A)	v. (C)
vi.(C)	vii.(A)	viii.(D)	ix. (B)	x. (D)

UNIT 5

Q1. Select the best answer for the following MCQs.

i. (B)	ii. (B)	iii. (D)	iv. (A)	v. (D)
vi.(B)	vii.(D)	viii.(C)	ix. (A)	x. (B)

UNIT 6

Q1. Select the best answer for the following MCQs.

i. (B) ii. (D) iii. (C) iv. (C) v. (A)

vi.(A) vii.(A) viii.(C) ix. (C) x. (B)

UNIT 7

Q1. Select the best answer for the following MCQs.

i. (B) ii. (A) iii. (D) iv. (C) v. (C)

vi.(C) vii.(A) viii.(B) ix. (C) x. (D)

UNIT 8

Q1. Select the best answer for the following MCQs.

i. (C) ii. (B) iii. (D) iv. (C) v. (A)

vi.(C) vii.(C) viii.(B) ix. (D) x. (B)

Glossary

Application Software	A set of programs designed to perform a specific task, such as typing a letter, preparing payroll, playing music or creating animated display.
Assembler	A system software that translates assembly language programs into machine language for execution by the computer.
Asynchronous Transmission	A type of transmission in which the time interval between the characters being transmitted varies.
Attribute	A property or characteristic of an entity.
Bus Topology	A type of topology in which the transmission medium is usually a single cable to which all the devices are attached.
Cache Memory	Small amount of high-speed semiconductor memory which exists inside the microprocessor or on the motherboard of a computer.
Circuit Switched Network	A mode of operation of a network in which communication path is first established between the source and the destination and used exclusively for the duration of the call or transaction.
Client	A computer on the network that accesses resources that are shared by other computers.
Client/Server Network	A computer network in which each computer on the network acts as either a server or a client.
Communication Media	Communication lines used to transmit data between computers, such as telephone line, fiber optics or coaxial cable.
Compiler	A system software that translates entire program written in a high-level language into machine language program for execution by the computer.
Computer Casing	A box or an enclosure that contains most of the components of a computer except the input/output devices.
Computer Network	An interconnection between two or more computers so that they can communicate with each other.
Computer Program	A sequence of instructions which are stored in main memory of a computer and specify which operations are to occur to solve a problem.
Control Unit	A unit of CPU that directs and coordinates the operations of entire computer system.

Data File	A collection of records.
Data Inconsistency	The same items of data held in many different files having different values.
Data Redundancy	The same data duplicated in many different data files.
Database	A collection of related data in data files or tables.
Database Management System (DBMS)	A general-purpose software that allows users to create and maintain a database.
Database Administrator	A person in charge of a group who is responsible for supervising both the database and the use of DBMS.
Database	A collection of many different data files linked in such a way that information can be retrieved from several files simultaneously.
Device Driver	A computer program whose purpose is to control the operation of a hardware device attached to computer.
Digital Computer	A machine that can solve problems by carrying out instructions given to it in a computer programming language.
Direct Access Memory	A type of memory in which the actual physical location of a memory word has no effect on how long it takes to read from or write into that location.
Entity	A thing of interest to an organization about which data is to be held.
Entity-Relationship Diagram	A diagrammatic way of representing the relationship between entities in a database.
Firmware	An intermediate form between hardware and software which consists of software embedded in electronic devices during their manufacture.
Form	A window that displays a collection of controls, such as labels, text boxes, check boxes and lists for viewing, entering and editing the information in database fields.
Freeware	Software distributed free of cost like shareware but it is usually full version of the software for an unlimited period of time.
Full-duplex Mode	A type of information exchange method between two communicating devices whereas information can be exchanged in both directions simultaneously.

Gateway	A device that is used to link very different kinds of networks, such as a network of IBM mainframe computers and a network of PCs.
Half-duplex Mode	A type of information exchange method between two communicating devices whereas information can be exchanged in both directions alternatively.
Hardcopy	Output generated by an output device, such as printer on paper that is permanent record of information and cannot be changed.
Hardware	Physical components of computer, such as monitor, keyboard, hard disk, printer, along with the circuitry connecting them.
Hierarchical Database Model	A database model in which data is organized into a tree-like structure.
Hyper Text Markup Language(HTML)	The major language of the Internet's World Wide Web to write web pages.
IC Chip	A silicon chip that consists of miniature logic circuits etched on it.
Interpreter	A system software that translates high-level language program into machine language but it translates one instruction at a time and executes it before translating the next instruction.
IP Address	A unique address made up of 32 bits that identifies a host on Internet.
ISO	International Standards Organization, based in Geneva that develops standards for various devices.
Local Area Network (LAN)	A network that consists within a limited geographical area such as a building or a university campus.
Memory Address	A number that points at a location of a word in memory.
Metropolitan Area Network(MAN)	A backbone network of fiber optic cables that could span hundreds of square miles within a city.
Microprocessor	A single VLSI chip that directs and coordinates the operation of all the other part of computer.
Modulation	The process of transmitting a sequence of 1s and 0s by varying amplitude or frequency of a sine wave.
Motherboard	A circuit board that connects all the components of computer system through ports, cables or expansion slots.

Network Database Model	A hierarchical database model in which some of the data elements can have more than one owner data element.
Object-Oriented Database Model	A database model that stores objects rather than data, such as integers, real numbers and strings. Objects are used in object-oriented programming languages, such as C++ and Java.
Open Source Software	Computer software that is available in the form of source code that allows users to study, change and improve it.
Operating System	A system software that manages the hardware and software resources of a computer system, such as CPU, storage and all the input/output devices.
OSI	Open System Interconnection is a standard model of a data communication system developed by ISO to facilitate communication system in which equipment from different vendors can communicate with each other.
Packet Switched Network	A mode of operation in which each message transmitted through the network is first divided into a number of smaller units known as packets. Each packet contains addressing information and the packets are reassembled at the destination.
Peer-to-Peer Network	A network in which every computer is capable of playing the role of client, server or both at the same time.
Plotter	An output device used to produce hardcopy of graphs, maps, engineering drawings and machine components.
Port	Connectors at the back of motherboard that provide interface for communication between the microprocessor and input/output devices.
Primary Key	A unique field of an entity in a database.
Protocol	A language or set of rules that nodes agree to use to communicate over a network.
Query	An object used to gather selected information from a database and organize it either for use in reports or for viewing on screen
Record	All the information about one person or item.
Referential Integrity	A feature in DBMS that prevents from deleting or modifying values of a primary table's record on which related records depend.
Register	Small storage unit whose function is to temporarily store binary information and pass it on to the other parts of the processor or main memory during the execution of program instructions.

Relational Database Model	A database model in which data is held in tables and the tables are linked by means of common fields.
Relationship	A link or association between entities.
Resolution	The sharpness or quality of picture or text displayed on monitor or printed on printer.
Ring Topology	A type of topology in which each computer is connected to its nearest neighbor until all the computers are connected in the form of a ring.
Router	A device that reads network addressing information in the packet and may add more information to get it through the network.
Secondary Key	If a database table needs to be searched on a field other than the primary key, it is known as a secondary key.
Sequential Access Memory	A type of memory in which the access time is not constant but varies depending on the address location.
Server	A computer on the network that shares resources for others to use.
Shareware	A proprietary software that is given to people free of charge in a compact disk along with periodicals or magazines or it can be downloaded from a website.
Simplex Mode	A type of information exchange method between two communicating devices whereas information can be passed only in one direction.
Softcopy	Output that appears on a monitor or is saved on some medium, such as hard disk, CD or flash drive.
Software	See definition of computer program.
Software License	A contract between the producer and the user of computer software that specifies the perimeters of permission granted by the owner to the user.
Star Topology	A type of topology in which there is a central computer that performs all the switching functions.
Switch	A device that links cable segments of a LAN, links two LANs or links the cable of LAN to leased lines, such as telephone lines.
Synchronous Transmission	A type of transmission in which the time interval between characters being transmitted is constant.
System Bus	A group of parallel strands of wires for transmitting binary information in the computers.

System Software	Collection of operative programs whose purpose is to make the use of computer easy and effective.
System Unit	A computer casing with all the components, such as motherboard, CPU, main memory and hard disk installed inside it.
Topology	A map of layout of nodes and connections in a network.
Utility Software	Software that provides facilities to carry out tasks which are beyond the capabilities of the supervisor of operating system.
Virtual Private Network (VPN)	A network that provides remote access to individuals or offices to their organization's networks by using public telecommunication infrastructure such as Internet.
Wide Area Network (WAN)	A network that spans a large physical area, connecting computers across cities, countries and continents.
Wireless Network	A network that uses electromagnetic waves to provide facilities to computer users to exchange information without additional wiring network.

ABBREVIATIONS

ABBREVIATION	DESCRIPTION
ATM	Automated Teller Machine
BIOS	Basic Input Output System
BIPS	Billion Instructions Per Second
CD	Compact Disk
CISC	Complex Instruction Set Computer
CRT	Cathode Ray Tube
DBA	Database Administrator
DBMS	Database Management System
DIMM	Dual In-line Memory Module
DRAM	Dynamic Random Access Memory
DSL	Digital Subscriber Line
DVD	Digital Video Disk
EEPROM	Electrically Erasable Programmable Read Only Memory
EPROM	Erasable Programmable Read Only Memory
GB	Gigabyte
GPS	Global Positioning System
IBM	International Business Machines
IC	Integrated Circuit
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
KB	Kilobyte
LAN	Local Area Network
LCD	Liquid Crystal Display
LSI	Large Scale Integration
MAN	Metropolitan Area Network
MB	Megabyte

MIPS	Million Instructions Per Second
MSI	Medium Scale Integration
NIC	Network Interface Card
OSI	Open System Interconnection
PDA	Personal Digital Assistant
PROM	Programmable Read Only Memory
PSTN	Public Switched Telephone Network
RAM	Random Access Memory
RDBMS	Relational Database Management System
RISC	Reduced Instruction Set Computer
ROM	Read Only Memory
SATA	Serial Advanced Technology Attachment
SDRAM	Synchronous Dynamic Random Access Memory
SIMM	Single In-line Memory Module
SSI	Small Scale Integration
TB	Terabyte
TCP	Transmission Control Protocol
TIPS	Trillion Instructions Per Second
USB	Universal Serial Bus
VLSI	Very Large Scale Integration
VPN	Virtual Private network
WAN	Wide Area Network
WWW	World Wide Web

Content Authors

Mohammad Sajjad Heder

Mohammad Sajjad Heder has done Master (MS) in Computer Science from George Mason University, Virginia, USA and B.E. Mechanical Engineering from Kim Check Engineering College, Korea. He has profound knowledge of computers and is highly experienced in teaching the subject of Computer Science. He has been teaching Computer Science to students of SSC and HSSC for the last twenty years. He is the author of previous HSSC-I & II textbooks of Computer Science. These books were approved by Ministry of Education, Islamabad and prescribed by the Federal Board of Intermediate and Secondary Education for about twenty years.

Mohammad Khalid

Mohammad Khalid is Head of Computer Science Department at OPF Boys College, Islamabad. He did his MS in Computer Science from the University of Peshawar and earned his B.Ed. degree in Science from Institute of Education and Research, University of Peshawar. He has been instructor and teacher in Computer Science for the last fifteen years. He has vast teaching experience from Secondary to Masters Level. He has attended many national and international level seminars and meetings for the promotion of teaching Computer Science at different levels.

He has been member of the National Curriculum development team since 2007. He has contributed a great deal in writing the Curriculum of Computer Education from Grades VI-VIII and Curriculum of Computer Science from Grades IX-XII.

As an author he has written many textbooks of Computer Science for different Textbook boards.

Keeping in view his experience and expertise in the subject, this book will prove to be an asset both for the students and the teachers.

PEDAGOGICAL AUTHOR

Dr. Rahat Hussain Bokhari

Ph.D in Information Systems from Brunel University, Uxbridge West London, U.K., also Gold Medalist in M.Sc (Physics) from Islamia University, Bahawalpur.

Dr. Rahat Hussain Bokhari has done professional courses and training in Computer Sciences from 1977 to 2013. He has performed command over the Computer Technology and Information Technology skills. Due to vast and longtime experience in the field of computer sciences, he is well versed in e-government, software engineering and computer knowledge management.

He is holding membership of Academic Council, Board of Studies and Board of Faculty of well reputed universities of Pakistan. His articles and publications on Information Technology are par-excellence. He has professional experience of Research Officer, System Analyst and Director in different high esteemed institutions as well.

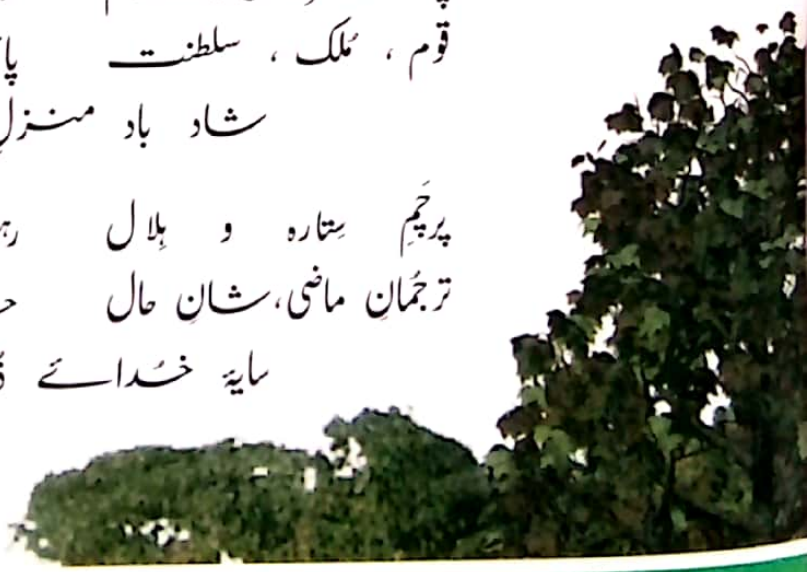
Approved by the Capital Administration & Development Division
(Curriculum Development & Textbook Production Wing),
Government of Pakistan, Islamabad,
vide letter No. F.1-3/2011/AFA (BS) Dated: 8-11-2012

قومی ترانہ

پاک سَر زمین شاد باد! کشورِ حسین شاد باد!
تو نِشانِ عزمِ عالی شان ارضِ پاکستان
مرکزِ یقین شاد باد!

پاک سر زمین کا نِظام قُوّتِ اُخوّتِ عوام
قوم ، مُلک ، سلطنت پائندہ تابندہ باد!
شاد باد منزلِ مُراد!

پرچَمِ سِتارہ و ہِلال رہبرِ ترقی و کمال
ترجُمانِ ماضی، شانِ حال جانِ اِستقبال
سایۂ خُدائے ذُوالجلال!



National Book Foundation
as
Federal Textbook Board
Islamabad